

# RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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## CONTENTS

THE RADIOLOGIC DIFFERENTIAL DIAGNOSIS OF ABDOMINAL TRAUMA. <i>J. H. Woodruff, Jr., M.D., R. E. Ottoman, M.D., J. H. Simonton, M.D., and B. D. Averbrook, M.D.</i>	641
CONTROLLED FRACTIONAL PNEUMOENCEPHALOGRAPHY, WITH PARTICULAR REFERENCE TO TECHNIC AND THE ANATOMY OF THE SUBARACHNOID CISTERNS. <i>Robert Shapiro, M.D., and Franklin Robinson, M.D.</i>	651
STAPHYLOCOCCAL PNEUMONIA IN CHILDREN AND ADULTS. <i>Harvey I. Meyers, M.D., and George Jacobson, M.D.</i>	665
THE BONE LESIONS OF CHILDHOOD LEUKEMIA. A SURVEY OF 140 CASES. <i>James K. V. Willson, M.D.</i>	672
SUBPLEURAL INTERLOBULAR LYMPHECTASIA REFLECTING METASTATIC CARCINOMA. <i>Bertram Levin, M.D.</i>	682
THE RADIOGRAPHIC EVALUATION OF PULMONARY VASCULATURE IN CHIL- DREN WITH CONGENITAL CARDIOVASCULAR DISEASE. <i>Dolores-Crystal Arnois, M.D., Frederic N. Silverman, M.D., and Malcolm E. Turner, Ph.D.</i>	689
PLEURAL EFFUSIONS FOLLOWING SUPERVOLTAGE RADIATION FOR BREAST CARCINOMA. <i>Arnold L. Bachman, M.D., and Kevin Macken, M.D.</i>	699
ARTERIOVENOUS FISTULA OF THE LUNG. <i>Lieut. Billy P. Sammons, MC, USN</i>	710
AGNOGENIC MYELOID METAPLASIA. <i>Harold G. Jacobson, M.D., Hassan Fateh, M.D., Jerome H. Shapiro, M.D., Theodore H. Spaet, M.D., and Maxwell H. Poppel, M.D.</i>	716
COMPARISON OF THE USE OF STANDARD DEPTH DOSE DATA AT 250 KVP AND 2 MEV BY DIRECT MEASUREMENT OF TUMOR EXPOSURE DOSE IN VIVO. <i>Peter Wootton, B.Sc., and Simeon T. Cantril, M.D.</i>	726
AN APPROACH TO BIPLANE CINEANGIOCARDIOGRAPHY. 1. BACKGROUND AND OBJECTIVES. <i>Herbert L. Abrams, M.D.</i>	735
AN APPROACH TO BIPLANE CINEANGIOCARDIOGRAPHY. 2. EQUIPMENT AND PROCEDURE. <i>Herbert L. Abrams, M.D.</i>	741
GENERALIZED SKIN REACTION FOLLOWING DEEP X-RAY THERAPY. <i>Andrew P. Dedick, Jr., M.D., and Vincent M. Whelan, M.D.</i>	751
LIPOMAS OF THE COLON. REPORT OF A CASE IN A PATIENT WITH MULTIPLE NEUROFIBROMATOSIS (VON RECKLINGHAUSEN'S DISEASE). <i>Lieut. C. William Rogers, MC, USN</i>	754
PLASTIC AND NYLON APPLICATORS FOR COBALT TREATMENT OF CANCER OF THE UTERINE CERVIX BY THE "REVISED" MANCHESTER SYSTEM. <i>J. G. Hockin, M.D., and F. D. Hankins, M.D.</i>	757
EDITORIAL: TEACHING OBJECTIVES IN DIAGNOSTIC ROENTGENOLOGY. <i>Robert S. Sherman, M.D.</i>	759
ANNOUNCEMENTS AND BOOK REVIEWS.	761
ABSTRACTS OF CURRENT LITERATURE.	766

# RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

PUBLISHED BY THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

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## The Radiologic Differential Diagnosis of Abdominal Trauma<sup>1</sup>

J. H. WOODRUFF, JR., M.D., R. E. OTTOMAN, M.D., J. H. SIMONTON, M.D., and B. D. AVERBROOK, M.D.

IN THE PAST twelve years 217 consecutive patients with abdominal injuries have been admitted to the operating rooms of the Los Angeles County Harbor General Hospital. In 198 of these patients roentgen examinations were performed prior to surgery. One hundred and fifty-nine of these roentgen examinations were available for review.

### METHOD OF STUDY

Clinical records and roentgenograms were reviewed in all of the cases. Information on the following points was recorded, when available, for each case: age and sex of patient; type of trauma (penetrating or nonpenetrating); history and physical findings; the highest recorded white blood cell count prior to surgery; presence or absence of hematuria; the findings on four quadrant taps; the finding of intra-abdominal fluid at surgery; roentgen evidence of fluid, enlarged spleen, or left upper quadrant density; size of the liver shadow; localized or generalized ileus; pneumoperitoneum; retroperitoneal hematoma; pleural effusion; elevation of the diaphragm; fractures of ribs, transverse processes, and pelvis; operative findings.

### GENERAL OBSERVATIONS

*Distribution of Sites of Injury:* One hundred and thirteen patients had nonpenetrating

TABLE I: CLASSIFICATION AND DISTRIBUTION OF ABDOMINAL INJURIES

	Single Site*		Multiple Sites		Total
	P.	N.P.	P.	N.P.	
Abdominal wall	46	2	0	0	48
Vascular	4	3	0	0	7
Diaphragm	2	2	9	2	15
Spleen	0	44	5	7	56
Stomach	3	0	12	1	16
Small intestine	9	3	17	5	34
Colon	3	1	12	1	17
Liver	5	9	9	5	28
Gallbladder	1	0	1	0	2
Pancreas	0	1	5	2	8
Kidney	3	7	4	5	19
Bladder	1	18	1	2	22
TOTAL	77	90	75	30	272

\* P. Penetrating trauma. N.P. Nonpenetrating trauma.

trating injuries and one hundred and four had penetrating injuries. In 167 cases there was only one major site of injury, while in 50 patients multiple major sites were involved. Multiple involvement was more frequent following penetrating trauma.

The commoner sites of injury were the spleen, abdominal wall, small intestine, liver, bladder, and kidney. Many kidney injuries are not included in the series studied, as no exploration was done. If clinical diagnosis had been accepted as the basis for comparison, there is no doubt but that the kidney would be the most frequently encountered site.

Table I tabulates the injuries by site and type of trauma.

<sup>1</sup> From the Departments of Radiology of the Los Angeles County Harbor General Hospital, Torrance, Calif., and the University of California, Los Angeles. Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16-21, 1958.

TABLE II: CLINICAL FINDINGS IN ABDOMINAL INJURIES

	Spleen	G.I. Tract	Liver	Kidney	Bladder
Age	Younger	Average*	Average*	Average*	Older
Type of trauma	Nonpenetrating	Penetrating 5:1	Both	Nonpenetrating 2:1	Nonpenetrating
Site of trauma	L.U.Q.	Varies	R.U.Q.	Costovertebral angle	Suprapubic
Leukocytosis	Highest	Average*	High	Average*	Average*
Hematuria	Common	Rare	Frequent	Higher	Highest
General condition	Poor	Average*	Poor	Average*	Poor

\* Average. As in series as a whole.

**Clinical Findings:** History and clinical findings were of some help in indicating the presence of internal injury and, infrequently, the site of involvement. Sometimes, when the patient was examined soon after the injury, physical findings were insignificant. At times this was true also of the x-ray findings. In some patients, there developed, under observation, physical or roentgen findings indicative of internal trauma, which sometimes suggested its location.

Table II summarizes the clinical and laboratory findings.

**Site of Trauma:** The organ or site of injury was generally beneath the area struck in cases of nonpenetrating trauma. In penetrating trauma, the injury generally, but not invariably, followed the estimated course of the weapon or missile. The course, and not the wound of entrance was the important consideration. This was estimated on the basis of the following observations: (a) wounds of entrance, and exit, (b) wound of entrance and location of opaque fragments of the missile, (c) direction of the wound as determined by probing.

Slater (6) believes that the course of the missile is more misleading than helpful in determining whether the peritoneum has been entered.

**Sex and Age:** One hundred and sixty-one patients were male and fifty-six were female. There did not appear to be any significant sex difference in the sites of injury. The greater incidence in males was explained by a greater exposure to trauma.

About 60 per cent of the patients were under thirty years of age (Table III). Splenic injuries were more common in a

TABLE III: AGE DISTRIBUTION OF PATIENTS WITH ABDOMINAL INJURIES

Years	Patients
0-10.....	22
10-20.....	34
21-30.....	63
31-40.....	47
41-50.....	38
51-60.....	8
61-80.....	3

TABLE IV: HIGHEST WHITE BLOOD CELL COUNT IN PATIENTS WITH ABDOMINAL INJURIES

White count (in thousands)	Patients
4-10.....	26
10-15.....	56
15-20.....	39
20-30.....	36
30-40.....	13
Over 40.....	15

relatively younger age group, and bladder injuries in an older one.

**Penetrating Versus Nonpenetrating Trauma:** The site injured seemed to vary with the type of trauma (Table I). Penetrating injuries occurred in the following order of frequency: abdominal wall, small intestine, stomach and colon, diaphragm.

The order of frequency for nonpenetrating trauma was: spleen, bladder, liver, kidney, small intestine. The low incidence of renal injuries is explained by the fact that only cases admitted to the operating room have been considered.

**Leukocytosis:** One hundred and eighty-five patients had white blood cell counts between admission and operation. The highest white cell count in this period was recorded for each patient. Table IV records the distribution of the counts. The highest counts tended to be associated with splenic and, to a lesser extent, with hepatic

TABLE V: ROENTGEN FINDINGS BY SITE OF ABDOMINAL INJURY

	Abdominal Wall Pos. * Cases		Vascular Pos. * Cases		Spleen Pos. * Cases		G.I. Tract Pos. * Cases		Liver Pos. * Cases		Kidney Pos. * Cases		Bladder Pos. * Cases	
Intraperitoneal fluid	9	20	2	4	28	40	4	13	6	11	2	7	5	15
L.U.Q. mass	2	31	1	4	34	41	1	14	1	11	0	6	0	15
R.U.Q. mass	0	31	0	4	1	41	0	12	2	11	2	6	0	15
Pneumoperitoneum	1	26	0	5	0	43	4	12	1	11	0	5	0	13
Retroperitoneal hematoma	0	28	1	5	4	41	1	13	1	11	7	10	0	15
Right pleural effusion	0	28	0	5	1	44	0	12	0	11	0	4	1	11
Left pleural effusion	2	28	1	5	6	44	0	12	0	11	0	4	0	11
Elevated right diaphragm	1	28	0	5	0	43	0	12	2	11	1	5	0	11
Elevated left diaphragm	2	28	3	5	11	43	2	12	0	11	0	5	0	11
Fractures of right ribs	0	30	0	5	1	44	0	13	1	11	1	7	1	18
Fractures of left ribs	1	30	0	5	5	44	0	13	0	11	0	7	0	18
Fractures of pelvis	1	30	0	5	1	44	0	13	0	11	0	7	12	18
Fractures of the transverse processes	0	30	0	5	0	44	0	13	0	11	1	7	0	18

\* Positive.

injuries. Otherwise there did not seem to be any significant difference in this respect by sites of injury or severity of trauma.

**Hematuria:** The majority of patients having nonpenetrating injuries will show some degree of hematuria. Gross or very heavy microscopic hematuria was generally indicative of severe urinary tract injury.

**General Condition:** As a rule, patients with injuries confined to the abdominal wall and minor intra-abdominal injuries were in the best general condition; patients with small-intestinal, gastric, colonic, and renal injuries were in an intermediate or average general condition for the series; patients with splenic, bladder, and liver injuries were in poorer condition.

**Four Quadrant Taps:** Thirty-three patients had four quadrant taps, with 30 showing positive results. Three of the 30 had negative first taps followed by positive findings on the repeat study. All positive results were confirmed at surgery. The 3 patients with negative findings were found at operation to have hemoperitoneum. The site of the positive tap did not appear to be correlated with the site of injury. In 27 cases the fluid recovered was blood. In 1 of the remaining 3, with small intestinal

perforation, intestinal contents were recovered. In a second, who had a fractured bladder, a blood-stained yellowish fluid was obtained. The third, a cirrhotic, showed a yellowish fluid which was due to ascites.

#### ROENTGEN FINDINGS

The method of roentgen examination varied with the type of injury, the condition of the patient, and associated injuries. Some examinations did not permit an adequate study of all the features listed for evaluation (for example, pneumoperitoneum). In such cases only those findings suitably demonstrated were recorded and the case was excluded from the total number of cases in which the particular finding was evaluated. This did not preclude evaluation for other features adequately demonstrated.

The films were reviewed and the observations were recorded. Table V shows the incidence of positive findings relative to the number of cases of injury to a single site in which that finding could be evaluated. Table VI shows the incidence of positive findings in single site injuries in relation to the total incidence of the positive findings in the cases tabulated.

TABLE VI: RATIO OF A SPECIFIC ROENTGEN FINDING PER SITE TO THE FINDING IN ALL SITES

	Abdominal Wall	Vascular	Spleen	G.I. Tract	Liver	Kidney	Bladder
Intraperitoneal fluid (roentgen)	9/56	2/56	28/56	4/56	6/56	2/56	5/56
Intraperitoneal fluid at surgery	8/85	5/85	42/85	10/85	11/85	2/85	7/85
L.U.Q. mass or density	2/39	1/39	34/39	1/39	1/39	0/39	0/39
Pneumoperitoneum	1/6	0/6	0/6	4/6	1/6	0/6	0/6

*Intra-Abdominal Fluid:* Roentgen evidence of intra-abdominal fluid was frequently obtained. False positive roentgen diagnoses were infrequent, but false negative diagnoses were common. The false negative reports were not limited to cases with minimal fluid.

In Table VI the positive roentgenographic and surgical findings of intra-abdominal fluid are compared. In about half the cases the fluid was due to a splenic injury. Of 44 patients with splenic fractures unassociated with any other major injury, 42 showed evidence of hemoperitoneum at surgery. X-ray findings were positive for abdominal fluid in 28 of 40 cases. Other injuries in which massive hemoperitoneum was a not uncommon finding were those involving the liver, bladder, and mesenteric and other vascular structures. Fluid in the abdominal cavity was a common observation, also, in penetrating injuries of the abdominal wall, and perforations of the small intestine, stomach, and colon.

Improvement in the demonstration of intra-abdominal fluid should follow the use of both lateral decubitus views, in addition to an anteroposterior view with the patient recumbent (Frimann-Dahl, 3). When feasible an erect anteroposterior view will also prove helpful. The demonstration of shifting densities serves to establish the presence of fluid.

Spontaneous pneumoperitoneum has helped to reveal small quantities of fluid. We have not had the opportunity of using artificial pneumoperitoneum as advocated by Birsner (2).

Four quadrant taps (see above) have proved generally reliable for the demonstration of intra-abdominal fluid.

*Left Upper Quadrant Mass:* A distinctly enlarged splenic mass was not difficult to identify. An increase in density due to splenic and perisplenic enlargement with no clear outline was harder to evaluate, but was more frequently encountered. The left upper quadrant, because of gastric and colonic gas content, presented a shadow much less dense than that of the liver in the right upper quadrant. When the left upper quadrant density approached that of the right, one's suspicions were aroused. Erect and/or lateral decubitus views should be made to exclude a fluid-filled stomach or colon as the cause of this density. Elevation of the left diaphragm, displacement and extrinsic pressure on the stomach, inferior displacement of the splenic flexure of the colon and/or of the left kidney may support the impression of a mass in the splenic fossa. The splenic mass was easily "burnt out" on dense films and was sometimes appreciated only on chest films (Fig. 1) on which the left upper quadrant area was underexposed.

It was apparent that different observers could have different opinions concerning the presence or the absence of a splenic mass. In this series there were 41 cases with solitary splenic injuries in which films were evaluated in this respect. In 34 of these patients a splenic mass or left upper quadrant density was noted. In 5 other cases, with no intra-abdominal injury to account for the finding, a similar diagnosis was made. In 2 of these there was a hematoma of the anterior left upper quadrant wall which probably explains the findings. It appears that this finding was highly specific for splenic injury but was liable to occasional false negative and false positive interpretations.

**Right Upper Quadrant Mass:** The demonstration of a right upper quadrant density larger than the normal liver shadow was infrequent (4 per cent of the patients). In 2 of 11 injuries confined to the liver this finding was observed. Two cases of injury to the right kidney showed a retroperitoneal hematoma which blended with the liver shadow and presented the appearance of an increased right upper quadrant density. The differential diagnosis was made more difficult by the fact that hepatic injuries may be accompanied by a right-sided retroperitoneal hematoma. Urograms and pyelograms helped in this differential diagnosis by demonstrating evidence of renal injury.

**Pneumoperitoneum:** Pneumoperitoneum was found 9 times and retroperitoneal emphysema once in the entire series. Pneumoperitoneum occurred in 2 of a total of 29 wounds which penetrated the abdominal wall, with no perforation of a hollow viscus.

Twenty-seven patients with perforations of gastrointestinal tract organs were found to have satisfactory films, with 7 showing pneumoperitoneum and 1 retroperitoneal emphysema. The single example of retroperitoneal emphysema occurred in 1 of 2 patients with perforation of the second portion of the duodenum.

None of 6 patients with gastric perforations showed pneumoperitoneum. Five of the cases occurred in 15 patients with perforations of the small intestine and 2 among 9 patients with perforations of the colon. Since the majority of these patients had penetrating abdominal wounds, it could be argued that the pneumoperitoneum was due to the abdominal wall perforation, and not to that of the hollow viscus. The greater incidence of pneumoperitoneum in cases with gastrointestinal tract perforations (7 of 30), however, compared to that (2 of 29) in perforations confined to the abdominal wall, would seem to support the opposite contention.

The paucity of findings in perforations of the gastrointestinal tract was quite disappointing. Erect chest films, erect an-

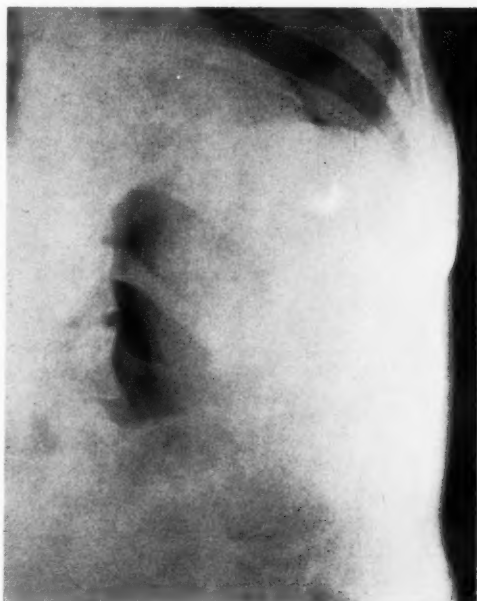


Fig. 1. A 32-year-old pregnant (four months) white female was struck and thrown to the floor by her husband. After the injury the patient was weak and dizzy. There was diffuse abdominal pain referred to both shoulders and aggravated by motion and respiration. Tenderness on motion of the uterine cervix to the right was noted. Surgery was done after eight days of observation. The preoperative diagnosis was ruptured ectopic pregnancy. A hemoperitoneum and lacerated spleen with perisplenic hematoma was found. The roentgenogram shows a splenic mass encroaching on and displacing the gastric air bubble to the right. Proper interpretation of this finding should have led to the diagnosis, or at least to a strong suspicion of splenic rupture.

teroposterior films of the abdomen, and lateral decubitus films were all used. In every case at least one of these views was obtained, and in many of the cases all three. The studies were essentially the same as those which have demonstrated "free air" in 77.5 per cent of our cases of perforated peptic ulcer. Slater (6), in studying battle casualties advocated a translateral view with the patient in Fowler's position and claimed nearly 100 per cent effectiveness. We propose to evaluate this technic.

Pneumoperitoneum in the absence of penetrating trauma was highly specific for perforation of a hollow gastrointestinal tract viscus. Even in the presence of a penetrating wound, pneumoperitoneum





Fig. 2. A 19-year-old male was knocked unconscious in an auto accident. On hospital admission he had a painful abdomen with rebound tenderness and rigidity. Pain was referred to the right shoulder. Bowel sounds were active. Under observation the abdomen became silent and tenderness became localized in the left upper quadrant. No four-quadrant tap was done.

In addition to usual projections of the abdomen and chest, an aortogram was obtained. This study shows extravasation of contrast medium outside the lumens of the smaller splenic vessels. A well defined splenic mass was present, and this alone should have indicated the correct diagnosis.

Surgery was performed two days after admission and a transverse laceration of the spleen and a large hemoperitoneum were found.

was generally due to perforation of the intestinal tract.

**Retroperitoneal Hematoma:** Half of the cases showing retroperitoneal hematoma in this series were injuries of the kidneys. The next most common cause of retroperitoneal hematoma was splenic trauma, which accounted for about 30 per cent of the incidence of this finding. Among other causes were injuries to the mesenteric vessels and liver.

Retroperitoneal hematoma was considered to be present when obliteration of the psoas muscle shadow was accompanied by a local increase in density. Obliteration of the renal outline, renal displacement, ureteral displacement, and a scoliosis

concavity toward the injured side were sometimes present.

**Pleural Fluid:** Pleural fluid was secondary to subdiaphragmatic or thoracic trauma. Six of 9 left pleural effusions were associated with splenic trauma.

**Diaphragmatic Elevations:** Two of 4 right diaphragmatic elevations were associated with liver injuries and 1 with a right renal injury. Eleven of 18 left diaphragmatic elevations were associated with splenic injuries.

**Fractures:** Four patients had fractures of the right ribs. One had a liver injury, another a right kidney injury, and the others injury to the spleen or bladder. Six patients had fractures of the left ribs, and 5 of these had splenic injuries.

Fractures of the pelvis were present in 14 patients, 12 of whom had lacerations of the bladder.

**Cystograms:** Cystograms were obtained in 20 patients with perforations of the bladder. Extravasation of contrast medium into the perivesical space or peritoneal cavity was demonstrated in 19. Postvoiding views may reveal extravasation not seen on anteroposterior and oblique prevoiding films. Incomplete return of the injected contrast material was also noted. Urograms were less reliable in the demonstration of bladder injuries.

Elongation and/or elevation of the bladder shadow occurred secondary to perivesical hematoma.

**Urograms:** Urograms were obtained in 14 cases of renal injury. Six of these showed extravasation. Four others showed such changes as (1) nonvisualization of the involved kidney, (2) decreased visualization of all or part of the injured kidney, (3) distortion of the pelvicalyceal system secondary to extrinsic pressure from an intrarenal hematoma.

Urograms demonstrating the function of the contralateral kidney, were of considerable value when nephrectomy became necessary.

**Retrograde Pyelograms:** Retrograde pyelography was sometimes successful in

demonstrating evidence of renal trauma when urograms had been inconclusive. There were no evidences of any complications secondary to its use in our cases.

**Aortography:** Aortography was done in 3 cases in this series and in 5 cases of renal injury not included in this study. Two cases of suspected splenic trauma were examined by this procedure. In 1 there were no positive findings and at surgery the spleen showed no evidence of trauma. In the other, extravasation of contrast substance outside the splenic vascular tree was noted. One renal injury showed a similar extravasation. Most commonly areas of avascularity secondary to arterial thrombosis, spasm, or compression by extravascular hematoma were found.

It is questionable if aortography has any place in the study of splenic injuries. Further investigation of its value as a guide to treatment of renal vascular injuries would appear to be of interest. It would seem most appropriate to the study of post-traumatic renal hypertension. The demonstration of acute, possibly transient vascular changes is of interest but appears to be of less therapeutic importance.

#### DIFFERENTIAL DIAGNOSIS

Tables II and V combined give the differential considerations between the major sites of trauma.

**Spleen:** Splenic injuries were generally due to nonpenetrating trauma in the region of the left upper quadrant. The patients were a little younger than in the series as a whole. These injuries were the commonest cause for a leukocytosis of over 30,000 per cubic millimeter. Hematuria was of frequent occurrence, but the number of red blood cells per high-power field was generally less than in the surgically explored bladder and renal injuries. The most frequent and most reliable x-ray finding was a left upper quadrant mass or density, observed in 70 to 85 per cent of the cases. Hemoperitoneum, found on 70 per cent of the x-ray examinations, is less specific.

Elevation of the left diaphragm was dem-

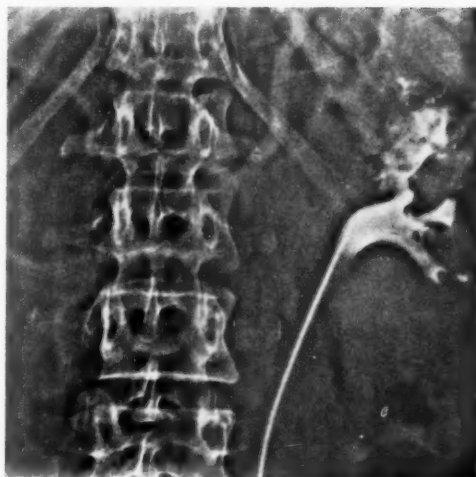


Fig. 3. A 43-year-old white female sustained an injury in a motor vehicle accident, followed by pain in the left flank, radiating around to the abdomen, and gross hematuria. On cystoscopy, blood was noted coming from the left ureteral orifice. A retrograde pyelogram demonstrated an intracortical extrapelvic calyceal extension of the contrast medium. Additional studies (not reproduced) included a preliminary film giving the impression of a left renal mass with indistinct left renal and left psoas outlines. A urogram showed nonvisualization on the left. A presacral gas injection demonstrated an obliteration of the perirenal space. The diagnosis at surgery was laceration of the left kidney with perirenal hematoma.

onstrated in about 25 per cent of splenic injuries. Two cases out of 3 with left sided diaphragmatic elevation had a splenic injury.

Fractures of the left lower ribs were found in about 11 per cent and in this series appeared generally to be associated with injury to the spleen.

Two out of 3 left pleural effusions were associated with splenic trauma and in about 14 per cent of the cases of splenic trauma such an effusion occurred.

**Bladder:** Nonpenetrating trauma to the pelvic area, gross hematuria and extravasation of contrast medium on cystography, or a "tear drop" deformity of the bladder, was characteristic of vesical or perivesical injury. A full bladder appeared to be more vulnerable to injury. Patients were generally older than in the series as a whole. The general condition showed evidence of a severe injury.

**Kidney:** Two out of 3 renal injuries were due to nonpenetrating trauma, usually to a costovertebral angle region. The patient generally did not appear as severely injured as when the bladder and spleen were involved. Costovertebral angle pain, tenderness, and fullness, along with gross or considerable microscopic hematuria, was the general rule. Retroperitoneal hematoma was a frequent finding. Urograms and pyelograms gave more specific information (see above).

**Intestinal Tract:** Patients with intestinal injuries when seen initially appeared to be in relatively good condition. Five-sixths of these cases were due to penetrating trauma. The course of the missile or weapon gave some clue to the structures involved.

Roentgen findings consisted of pneumoperitoneum and intra-abdominal fluid. Perforation of the posterior wall of the second portion of the duodenum by nonpenetrating trauma resulted in retroperitoneal emphysema in one case. Jacobson and Carter (4) reported a case of perforation of the duodenum with similar findings. In our case there was an interval of twenty-four hours between the radiographic examination and the injury. One other patient seen by one of us (JHW), but not included in this series, had a perforation of the second portion of the duodenum from nonpenetrating trauma. On the first examination, about one hour after injury, no pneumoperitoneum was found. About fifteen hours later, a large pneumoperitoneum was present. The time between injury and x-ray examination thus appears to be a factor in the demonstration of air escaping from a hollow viscus.

Positive findings of pneumoperitoneum or retroperitoneal emphysema were generally reliable, but absence of these findings was of no value in excluding intestinal injuries.

**Liver injuries** were due to either nonpenetrating or penetrating trauma to the right upper quadrant. In these patients the general condition tended to be poor, though in some cases symptoms were rel-

atively mild. The white blood cell counts showed a tendency to be high, second only to those associated with splenic trauma.

Roentgen findings in this group of cases were: hemoperitoneum, increase in the size of the liver shadow, elevation of the right diaphragm, retroperitoneal hematoma, and fractures of the right ribs. None of these findings were frequent or specific enough to be of any great diagnostic value. In consequence, the roentgen diagnosis could be suggested in relatively few cases.

**Injuries to the mesenteric and other extra-visceral vascular structures** were due to either penetrating or nonpenetrating trauma. The general condition of these patients suggested a severe injury. X-ray findings were hemoperitoneum and mass shadows produced by hematomas involving the mesentery or retroperitoneal areas. The diagnosis was difficult.

**Abdominal wall injuries** were usually due to penetrating trauma and in general the patients were in relatively good condition. The principal roentgen finding was hemoperitoneum. Pneumoperitoneum was demonstrated infrequently. Intra-abdominal masses were simulated by hematomas of the abdominal wall.

**Diaphragm:** About two out of three diaphragmatic injuries were due to penetrating trauma. The diagnosis was apparent radiologically only when accompanied by herniation into the hemithorax (Bernatz, 1).

**Gallbladder:** Only two cases of gallbladder injury were seen. Both were due to stab wounds. In one of these there appeared to be emphysema in the gallbladder fossa.

**Pancreas:** Five out of 8 pancreatic injuries were due to penetrating trauma. All but one pancreatic injury was associated with injuries to other sites. The one case in which the injury was confined to the pancreas showed a pressure defect on the barium-filled stomach and a thickening of the gastric mucosal folds.

In the cases with multiple site involvement there did not appear to be any local-

izing signs. It was not considered advisable to examine any of these patients with a barium meal.

The serum amylase may be elevated with pancreatic injury.

*Multiple injuries* were due to penetrating trauma in about two-thirds of the cases. The general condition of these patients was relatively poor. Roentgen findings were the same as for solitary sites but it was frequently difficult to appreciate all the injuries present, as signs of one tended to overshadow the others.

Many of the multiple injuries consisted of trauma to different segments of the intestinal tract. There were no reliable differentiating signs between injuries to the various segments.

#### CONTRIBUTION OF ROENTGEN STUDIES

About 45 per cent of the 159 patients whose x-ray examinations were reviewed had one or more roentgen findings, such as a left upper quadrant mass, extravasation of contrast medium, pneumoperitoneum, etc., which made a significant contribution to the diagnosis of the site of trauma. If incomplete and technically unsatisfactory examinations, were eliminated this percentage would be increased.

#### CONCLUSIONS

1. Two hundred and seventeen consecutive cases of abdominal trauma and the x-ray examinations in 159 cases have been reviewed and analyzed.

2. Careful correlation of all available information was necessary to achieve the maximum diagnostic accuracy in cases of abdominal trauma.

3. There was a high incidence of positive findings in cases involving the bladder, kidney, and spleen.

4. Pneumoperitoneum, when present, was a generally reliable indication of per-

foration of a hollow gastrointestinal tract viscus. Its absence was of little significance.

5. Injuries to the liver showed hemo-peritoneum and occasionally an enlargement of the normal right upper quadrant liver density.

6. The external site of trauma, when it was known, was generally over the site of internal trauma in the case of nonpenetrating injuries.

7. Injuries to the spleen, bladder, and kidney were generally due to nonpenetrating trauma. Intestinal tract injuries were frequently due to a penetrating wound.

8. Gross hematuria was frequent with urinary tract injuries. A considerable hematuria may accompany any nonpenetrating trauma and was presumed to be due to renal contusions.

9. High white blood cell counts were most frequently due to splenic trauma.

10. With injuries to multiple sites, the roentgen findings were less clear but still frequently contributed to the diagnosis.

ACKNOWLEDGMENT: We express our thanks to Mr. Paul Stout, photographer, and to Mrs. Edna B. Bannehr for preparing the manuscript.

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## SUMMARIO IN INTERLINGUA

## Le Diagnose Differential Radiologic De Trauma Abdominal

Es presentate un revista e analyse de 217 casos consecutive de trauma abdominal, con examines roentgenologic in 159 casos. Un caute correlation de omne disponibile informationes es necessari pro attinger le maximo de precision diagnostic in tal casos.

In casos in que le vesica, le renes, e le splen esseva interessate, le incidentia de constataciones positive esseva alte. Pneumoperitoneo, quando presente, esseva generalmente un indication definite de perforation de un cave viscere gastrointestinal. Su absentia habeva pauc significantia.

Lesiones del hepate monstrava hemoperitoneo e a vices allargamento del densitate normal in le quadrante dextero-superior del hepate.

Le sito externe del trauma, quando illo esseva cognoscite, esseva generalmente

supra le sito del trauma interne in le caso de lesiones nonpenetrante.

Lesiones del splen, del vesica, e del renes esseva generalmente debite a trauma nonpenetrante. Lesiones del tracto intestinal frequentemente esseva debite a un vulnere penetrante.

Hematuria grossier es un frequente occurrence in lesiones del vias urinari. Un grado considerabile de hematuria pote accompagner omne trauma nonpenetrante, e esseva considerate como debite a contusiones renal.

Anormalitate del numeration leucocytic esseva generalmente debite a trauma splenic.

In le caso de lesiones a sitios multiple le constataciones roentgenologic esseva minus clar, sed nonobstante illos frequentemente contribueva al diagnose.





# Controlled Fractional Pneumoencephalography

With Particular Reference to Technic and the Anatomy of the Subarachnoid Cisterns<sup>1</sup>

ROBERT SHAPIRO, M.D., and FRANKLIN ROBINSON, M.D.

THERE HAS BEEN no real standardization of pneumoencephalography in this country; this is true both of the roentgen technic and the method of gas-fluid replacement. In most clinics, varying amounts of cerebrospinal fluid are drained from the lumbar subarachnoid space prior to the introduction of air or other gases. The total amount of gas injected may vary from 50–100 c.c. to complete replacement of the cerebrospinal fluid reservoir. In view of the relatively uncontrolled nature of many of these studies, Falk has aptly remarked that encephalographic examinations often reveal more about the examiner than they do about the patient (3).

Two traditional objections to the use of encephalography in the diagnosis of expanding intracranial lesions have been (a) the risk of herniation of the cerebellar tonsils due to a rise in intracranial pressure and concomitant fall in lumbar pressure and (b) the frequent failure of ventricular filling, resulting in an unsatisfactory study. These objections are rightfully indictments of improper technic rather than of encephalography *per se*. In our experience, as well as that of others, pneumoencephalography provides more information than ventriculography in most cases, with little risk to the patient (2, 3, 8, 10–17).

The investigations of Robertson and Lindgren have firmly established that the ascent of gas into the ventricular system depends upon the position of the head (6, 8, 11, 12). Oddly enough, this simple fact is not generally known, nor is its significance fully appreciated. With the patient in the sitting position, gas injected into the lumbar subarachnoid space rises directly to the cisterna magna, after which

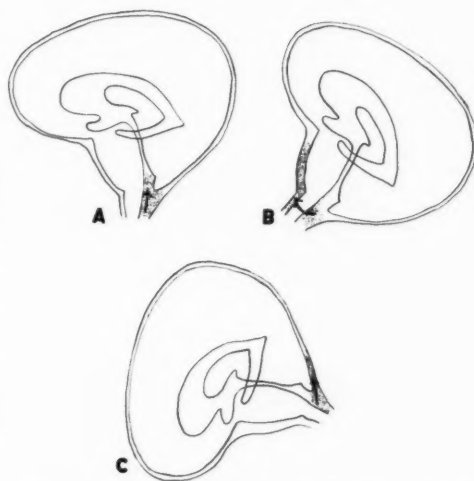


Fig. 1. Diagram showing the relationship of the air-filled cisterna magna to the foramen of Magendie in various positions of the head. A. Ideal position of moderate flexion. B. Hyperextension. C. Hyperflexion.

the further course is determined by the position of the head. In the ideal position of moderate flexion, gas ascends to the anterior central portion of the cisterna magna and then passes through the foramen of Magendie to the fourth ventricle, aqueduct, and posterior portion of the third ventricle (Fig. 1). With the head acutely flexed, gas collects in the posterior instead of the anterior portion of the cisterna magna and then courses over the dorsal surface of the cerebellum, where it may become arrested or pass forward under the tentorium to the cisterna venae magna cerebri. Little or no air enters the basilar cisterns with the head hyperflexed. Moreover, in acute flexion, there is little opportunity for ventricular filling, since the foramen of Magendie lies at the apex of the cisterna magna while the gas is confined to the posterior basilar portion

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erous cisterna magna with a capacity of 30 to 40 c.c. may fill with gas before the latter ascends into the fourth ventricle.

#### TECHNIC

Lumbar puncture is performed with the patient seated facing a vertical cassette holder with the head moderately flexed. Although the optimal degree of flexion may vary somewhat from patient to patient, it is better to err on the side of too much flexion, since too little favors filling of the basilar cisterns and potential collapse of the foramen of Magendie. Should this occur, gas may fail to enter the ventricles when the head is further flexed.

After the escape of a few drops of spinal fluid from the needle, 6 to 8 c.c. of air are

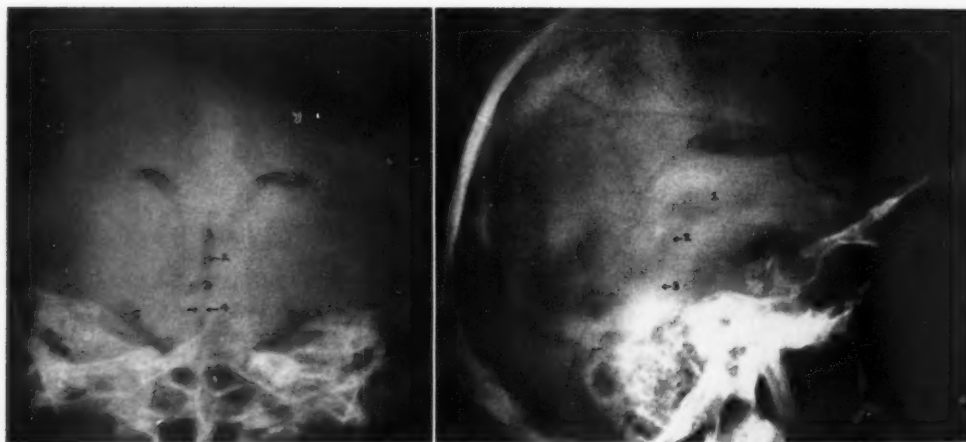


Fig. 2. Normal pneumoencephalogram (8 c.c. of air). 1. Third ventricle. 2. Aqueduct. 3. Fourth ventricle. 4. Vallicula. 5. Lateral extensions of cerebellopontine cistern.

of the cistern. With the head in the neutral or extended position, gas passes ventrally into the pontine and interpeduncular cisterns. Thereafter, depending upon the degree of extension, it may go posteriorly into the cisterna ambiens or anteriorly to the cisterna chiasmatis and cisterna laminae terminalis.

The normal cisterna magna varies considerably in size and occasionally in its superior extent. Usually gas passes promptly from a relatively small cisterna magna (5 to 10 c.c. capacity) through the foramen of Magendie into the fourth ventricle. Occasionally, however, a gas-

injected slowly. It is undesirable to allow the escape of any more fluid at this point because of the risk of collapse of the cisterns and the foramen of Magendie. This principle is in accord with Robertson's *in vitro* studies, which demonstrated that successful ventricular filling depends upon the tendency of gases to rise vertically in liquids. It is quite logical, therefore, to expect that ventricular filling will occur with greater ease when the subarachnoid spaces are normally distended with cerebrospinal fluid.

Following the initial injection, slightly overpenetrated postero-anterior (tube

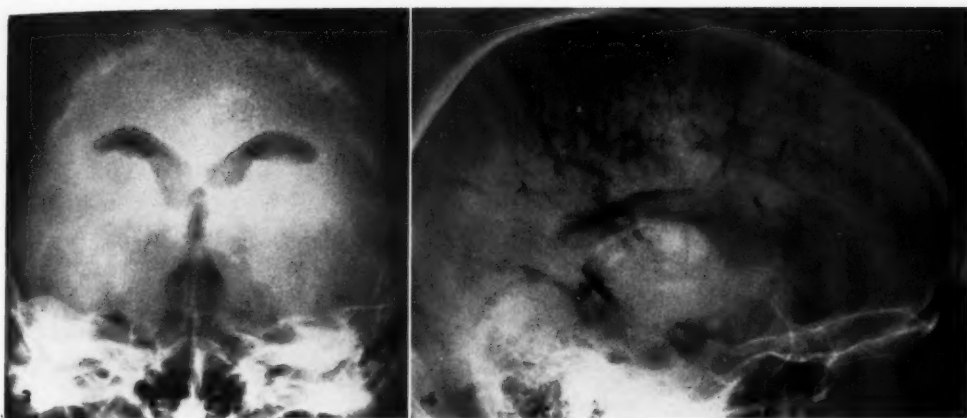


Fig. 3. Normal pneumoencephalogram (20 c.c. of air).

Fig. 4. Lateral pneumoencephalogram in a patient with seizures, showing air over the cerebral convexities.

tilted 15° cephalad) and lateral roentgenograms are made with the position of the head unchanged (Fig. 2). These are developed promptly and viewed. Usually there is excellent visualization of the fourth ventricle, aqueduct, and posterior portion of the third ventricle. Under these circumstances, an additional 10 to 15 c.c. of air are introduced after the removal of slightly less spinal fluid (Fig. 3). The last 5 c.c. of air are injected with the head slightly extended to insure filling of the ventral basilar cisterns. If it is desirable to visualize the sulci over the cerebral hemispheres, *e.g.*, in seizure problems or suspected convexity lesions, 5 to 10 c.c. of air are injected with the head in marked flexion (Fig. 4). The total amount of air routinely employed rarely exceeds 20 to 30 c.c. The aqueduct and fourth ventricle are sometimes obscured in the lateral view by a well pneumatized mastoid. This may be circumvented by rotation of the head from the true lateral into a slightly oblique position (*i.e.*, with the chin turned approximately 20° toward the cassette holder) (Fig. 5).

If the posterior midline structures are not adequately visualized on the preliminary films, an adjustment of the head position becomes necessary. The exact adjustment is determined by the location of the air. If this is in the posterior portion of the cisterna magna and the subarachnoid

space over the dorsal surface of the cerebellum, the flexion of the head is excessive and should be reduced. On the other hand, if the air is confined to the ventral basilar cisterns, there is too much extension and further flexion of the head is necessary. Following the appropriate adjustment, 4 to 6 c.c. of spinal fluid are removed and an additional 6 to 8 c.c. of air are injected. Another postero-anterior and lateral set of films is made, which usually shows satisfactory filling. With this technique, it has been our experience, as well as that of others, that successful ventricular filling can be achieved 90 per cent of the time (3).

Once satisfactory filling is obtained, the patient is placed in the supine position with the frontal horns up, and the following films are made:

1. An anteroposterior view with the central ray passing through the frontal horns.
2. An anteroposterior half-axial view with the tube tilted 30 to 35° toward the feet. This projection elongates the frontal horns and provides excellent visualization of the septum pellucidum, which is somewhat foreshortened in the straight anteroposterior view.
3. A lateral view. If the column of air does not extend as far back as the foramen of Monro, the head is hyperextended to allow the air to reach the interventricular

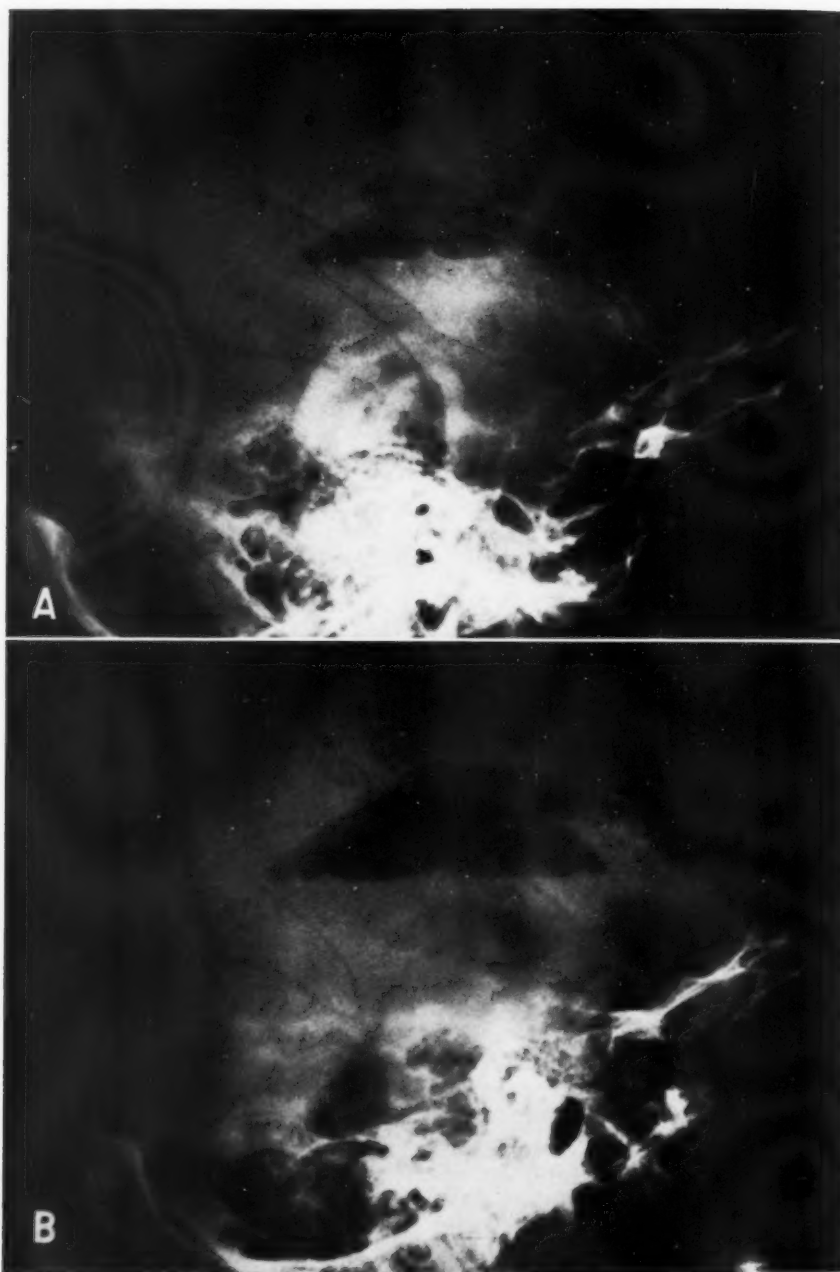


Fig. 5. A. Lateral pneumoencephalogram showing obscuration of the aqueduct and fourth ventricle by a well pneumatized mastoid.  
 B. Oblique view of same patient.

foramen and pass into the third ventricle. This maneuver also results in excellent visualization of the floor of the third ventricle.

The patient is turned slowly into the prone position, thereby filling the posterior portion of the lateral ventricles as well as the posterior half of the third ventricle.

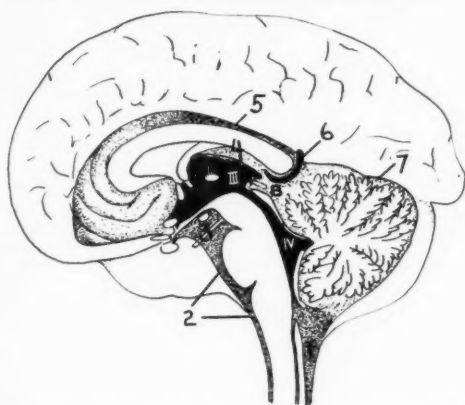


Fig. 6. Diagram of the ventricular system and cisterns in the lateral view. 1. Cisterna magna. 2. Cisterna pontomedullaris. 3. Cisterna interpeduncularis and cisterna chiasmatis demarcated by membrane. 4. Subarachnoid space over the third ventricle. 5. Cisterna corporis callosi. 6. Wing of the ambient cistern. 7. Subarachnoid space over the cerebellum. 8. Cisterna quadrigeminalis.

The following films are then made:

4. A postero-anterior view with the tube tilted  $10^\circ$  toward the head.
5. A postero-anterior half-axial view with the tube tilted  $30$  to  $35^\circ$  toward the head (reverse Towne view).
6. Lateral view.

Insufficient attention is generally given to the temporal horns. Thus in many clinics the only film specifically directed to these structures is a lateral view using the vertical beam, with the patient prone and the head turned to the side. In this position, the midportion of the temporal horn, being uppermost, is filled with air. The anterior tip, however, which lies more inferiorly, is not visualized. In order to insure filling of the entire temporal horn with air, the patient should be slowly turned from the prone into the supine position with the chin held close to the chest and the head slightly

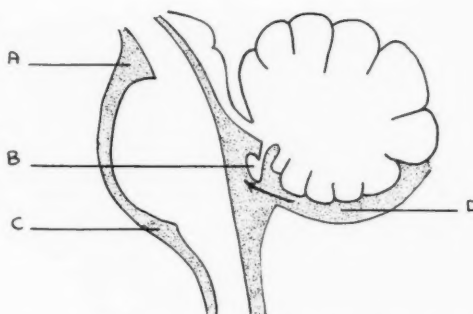


Fig. 7. Diagram showing the relationship of the cisterna magna to the foramen of Magendie in the lateral view. A. Cisterna interpeduncularis. B. Foramen of Magendie. C. Cisterna pontomedullaris. D. Cisterna magna.

inclined inferiorly and laterally. The purpose of this maneuver is to allow the air to pass along the lateral wall and floor of the uppermost lateral ventricle into the temporal horn, where it remains trapped. This procedure is repeated for the opposite temporal horn. The following films are taken for each horn:

7. An anteroposterior or a postero-anterior view as preferred, using the horizontal beam.

8. A lateral view with vertical beam. Several anteroposterior and postero-anterior projections of the temporal horns may be made with varying degrees of tube angulation if a temporal lobe lesion is suspected. As a routine procedure, this is unnecessary.

When this technic was first employed by the authors in 1951, the examination was routinely conducted with manometric control of the cerebrospinal fluid pressure. The normal spinal fluid pressure ranged from 310 to 570 mm. of water in the sitting position. The injection of 5 to 8 c.c. of air produced a rise in pressure ranging from 30 to 170 mm. of water (average 90 mm.). This transient elevation in pressure was always corrected by drainage of spinal fluid so that there was a restoration to the preinjection level following each injection of air. In over 100 studies monitored in this fashion, the spinal fluid pressure never fell below the preinjection level. Consequently, the criticism that pneumo-



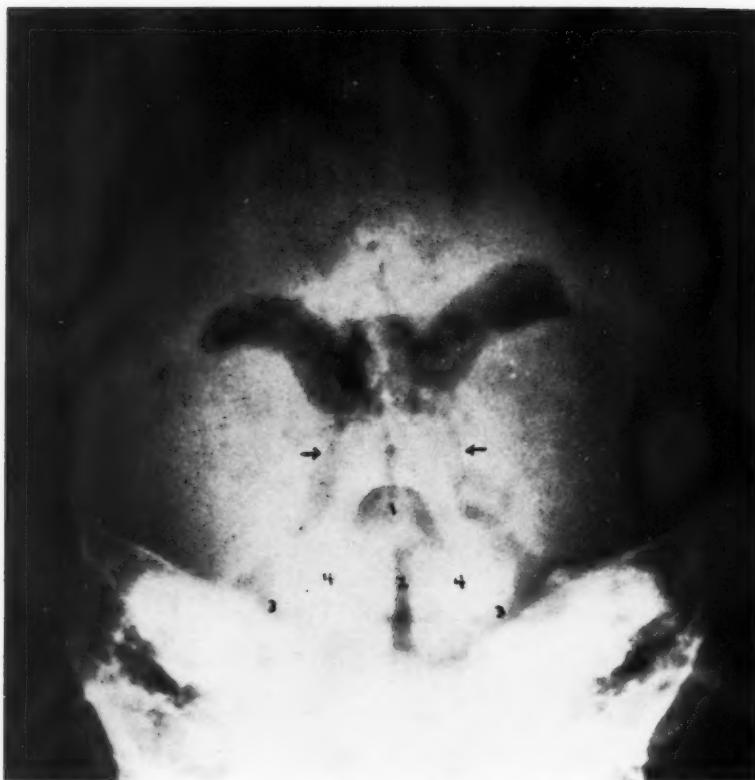


Fig. 8. Postero-anterior upright pneumoencephalogram showing the crural cisterns (arrows), the lateral extensions of the cerebellopontine cisterns (3), the vallecule (2), and the cerebellar tonsils (4). 1. Fourth ventricle.

encephalography promotes cerebellar tonsillar herniation due to a concomitant rise in intracranial pressure and fall in lumbar pressure is not true of this technic.

#### ANATOMY OF THE SUBARACHNOID CISTERNS

Early in the development of gastrointestinal radiology, diagnoses were made by recognition of gross deformities of the barium-filled stomach. As our diagnostic acumen improved, abnormalities of the mucosal pattern came to be appreciated. Similarly in pneumoencephalography, we first studied the contours of the gas-filled ventricles. In recent years, however, we have learned to appreciate the importance of the subarachnoid cisterns in the diagnosis of various intracranial lesions. Since the roentgen anatomy of the various cisterns is not as well known as that of the ventricles, a brief review seems appropriate (5, 16).

The following cisterns are of importance to the radiologist (Fig. 6):

The following cisterns are of importance to the radiologist (Fig. 6):

1. Cisterna magna (cerebello-medullaris)
2. Cisterna pontis
3. Cisterna interpeduncularis (basalis, intercruialis)
4. Cisterna chiasmatis
5. Cisterna laminae terminalis
6. Cisterna corporis callosi
7. Cisterna fissurae lateralis (fossae Sylviae)
8. Cisterna quadrigeminalis (venae magnae cerebri)
9. Cisterna cruralis
10. Cisterna ambiens



Fig. 9. Filling of the basilar cisterns without ventricular filling because of excessive extension of the head.

Fig. 10. Membrane separating the air-filled cisterna interpeduncularis from the fluid-filled cisterna chiasmatis anteriorly (arrows indicate site of membrane).

As it enters the foramen magnum, the cervical subarachnoid space expands to become the cisterna magna (Fig. 7). Inferiorly and ventrally the cisterna magna dips into the valley (vallecula) between the

cerebellar tonsils in the region of the foramen of Magendie. The vallecula can be recognized on the postero-anterior upright roentgenogram as the inferior central prolongation of the cisterna magna

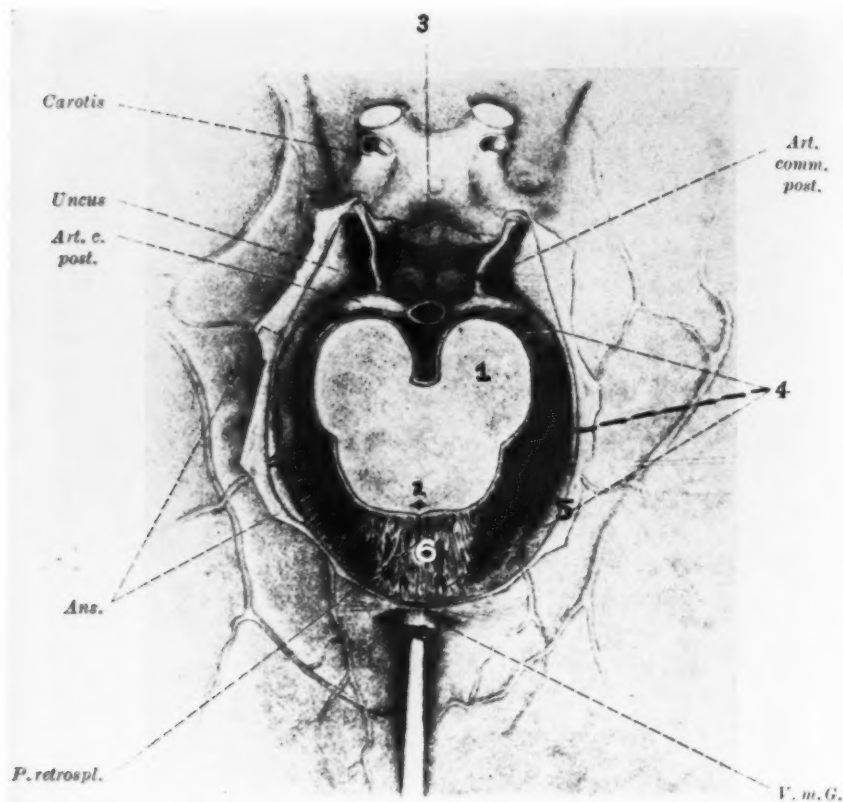


Fig. 11. Transverse section through midbrain showing the course of the cisterna interpeduncularis, cisterna cruralis, and cisterna ambiens. After Retzius.

1. Cerebral peduncles. 2. Aqueduct. 3. Cisterna interpeduncularis (intercruralis). 4. Cisterna cruralis. 5. Cisterna ambiens. 6. Cisterna quadrigeminalis.

framed on either side by the cerebellar tonsils (Fig. 8). Above the cerebellar vermis the great cistern terminates in a considerably narrowed subarachnoid space. Laterally and superiorly, the cisterna magna communicates on either side with the cerebellopontine extensions of the pontine cistern; ventrally it joins with the medullary cistern in front of the medulla. The pontine cistern, lying in front of the pons, is traversed by the basilar artery, which is frequently demonstrable as a vertical linear density in the gas-filled cistern. On either side of the pons, the pontine cistern extends into the cerebellopontine angle, where it communicates with the cisterna magna. This portion of the pontine cistern, termed the cerebello-

pontine cistern, is bounded above by the tentorium, in front by the posterior surface of the petrous pyramids, and behind by the anterior surface of the cerebellum. Superiorly, the pontine cistern merges with the interpeduncular cistern.

Interpeduncular cistern is the term used to designate the posterior half of the large ventral subarachnoid space between the anterior margin of the pons and the posterior margin of the optic chiasm. The anterior half of this space is called the chiasmatic cistern because of its intimate relationship to the optic chiasm (Fig. 9). Anteriorly, the chiasmatic cistern communicates with the cisterna laminae terminalis, which in turn merges with the cisterna corporis callosi at the genu of the corpus

callosum. Laterally, the chiasmatic cistern extends out into the sylvian fissure as the cisterna fissurae lateralis. Liliequist has called attention to a thin membrane which may separate the chiasmatic from the interpeduncular cistern (5). This membrane may be seen on the lateral encephalogram as a fine line bowed slightly anteriorly, extending from the tip of the dorsum sellae to the region of the mammillary bodies (Fig. 10). Liliequist has also pointed out that this membrane may be confused with the anterior margin of the chiasmatic cistern when air is arrested against the posterior surface of the optic chiasm and the chiasmatic cistern itself is unfilled. An important differential diagnostic feature is the forward curving convexity of the membrane in contradistinction to the straight posterior surface of the optic chiasm.

The interpeduncular cistern occupying the interpeduncular fossa extends laterally and inferiorly on each side to encircle the cerebral peduncles (Fig. 11). These lateral extensions, termed the crural cisterns, are bounded by the uncus laterally, the peduncles medially, and the optic tract superiorly. Postero-inferiorly they merge with the ambient cisterns. The crural cisterns can be recognized on the half-axial anteroposterior projection and on the postero-anterior view by the characteristic manner in which they fan out superiorly and laterally (Fig. 12). In the latter view, they cross the ambient cisterns. The crural cisterns should not be confused with the two narrow, cleft-like olfactory sulci which are seen only in the anteroposterior view and which lie closer to the midline and diverge less than the crural cisterns (Fig. 13, A, B, C). Nor should the crural cistern be confused with a superiorly displaced cerebellopontine cistern when the former is filled with air without filling of the latter. This error can be avoided by stereoscopic films or by films made with varying tube angulations, since these structures lie at different levels.

The crural cisterns continue posteriorly as the ambient cisterns, which in turn fuse

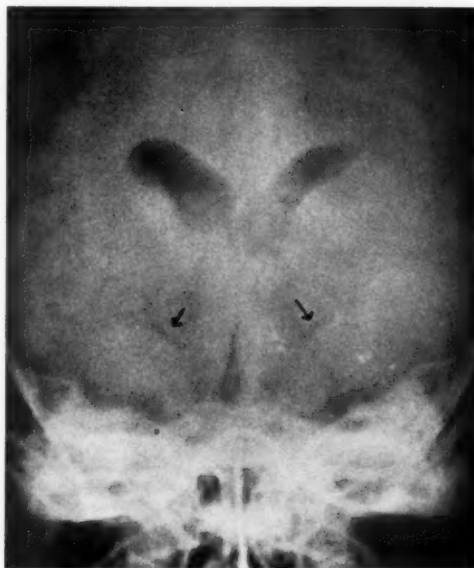


Fig. 12. Postero-anterior view showing the crural cisterns (arrows).

to form the cistern of the quadrigeminal plate. Anteriorly, where they communicate with the crural and pontine cisterns below the tentorium, the ambient cisterns are fairly large and broad. Posteriorly, the supratentorial portion of the ambient cistern is quite narrow and consequently cannot be recognized in the lateral view. The two thin, comma-shaped radiolucencies seen crossing the quadrigeminal plate in the lateral view lie around the thalamus in the frontal plane perpendicular to the ambient cistern proper (Fig. 14). These structures, called by some the wings of the ambient cistern, terminate inferiorly against the uncus.

The quadrigeminal cistern lies in the posterior portion of the tentorial notch just above the quadrigeminal plate. The pineal gland protrudes into the anterior portion of this cistern, while the great vein of Galen fills the upper portion (see Fig. 14). This cistern is bounded below by the quadrigeminal plate, above by the splenium of the corpus callosum, and posteriorly by the cerebellar vermis. The quadrigeminal cistern communicates laterally with the cisterna ambiens, anteriorly

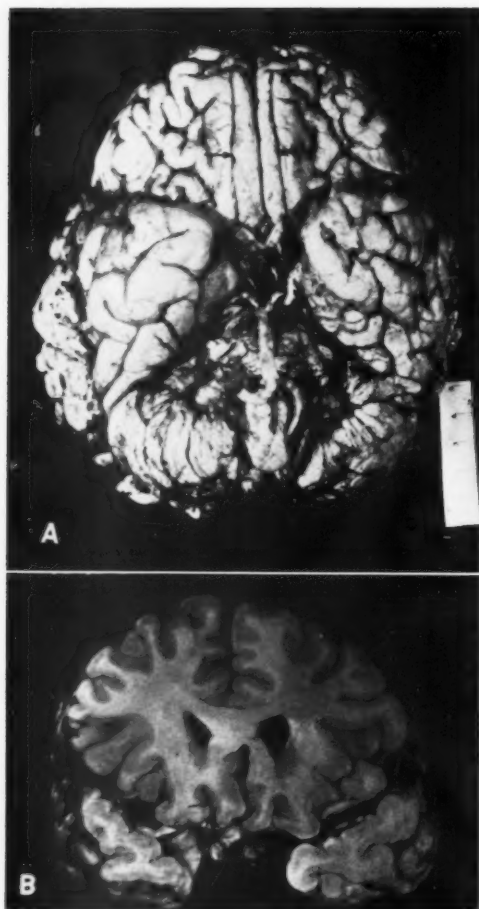


Fig. 13. A. Photograph of the ventral aspect of the brain. Arrows point to the olfactory sulci.

B. Photograph of a coronal section of the brain. Arrows point to the olfactory sulci.

Courtesy Drs. J. Hanelin, L. Bakay, and *Acta radiologica*.

with the subarachnoid space above the third ventricle, and posteriorly with the subarachnoid space around the cerebellar vermis.

Knowledge of the normal anatomy of the subarachnoid cisterns will make possible the recognition of cisternal deformities and thereby facilitate early and accurate diagnosis. This is particularly true of the following special circumstances:

1. *Differential diagnosis of tumors in the sellar region* (17). Visualization of the basilar cisterns may not only define the



Fig. 13. C. Pneumoencephalogram in the antero-posterior projection with the frontal horns up. Arrows point to the olfactory sulci.

size of the tumor but also indicate its origin as intrasellar, suprasellar extracerebral (e.g., meningioma of the tuberculum sellae), or suprasellar intracerebral (subfrontal glioma). Thus a tumor that is completely outlined by subarachnoid air must be extracerebral, whereas a tumor involving the anterior portion of the third ventricle, the stalk of which is outlined by air down to the sella, has its origin in the pituitary fossa (Fig. 15).

2. *Differential diagnosis of posterior fossa tumors* (7, 17). Deformity of the posterior fossa cisterns may permit the diagnosis of tumors too small to displace the aqueduct or fourth ventricle, e. g., acoustic neuroma. Similarly, it may facilitate the distinction between extra and intracerebral tumors, e.g., a tumor of the pons on the one hand and a meningioma of the clivus on the other, even though both of these lesions may produce similar displacement of the aqueduct and fourth ventricle (Fig. 18).

3. *Herniation of the cerebellar tonsils and the cerebral peduncles* (1, 4, 9). The demonstration of cerebellar tonsils dis-



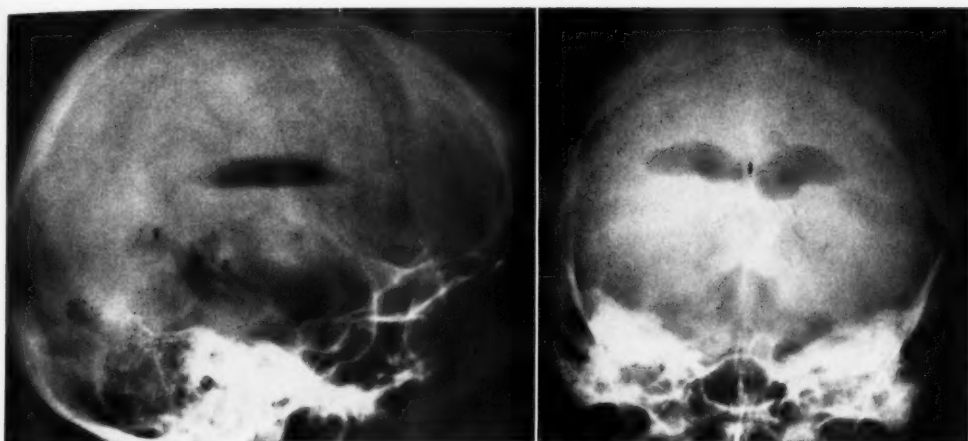


Fig. 14. Pneumoencephalograms, lateral and postero-anterior, showing prominent cisterna quadrigeminalis (1) and the wing of the ambient cistern (2).



Fig. 15. Lateral pneumoencephalogram showing elevation and displacement of the cisterna chiasmatis (arrows) by a chromophobe adenoma of the pituitary.

placed inferiorly into the cervical subarachnoid space may point up the need for special care and prompt surgical intervention (Fig. 17). Likewise, deformities of the crural and ambient cisterns indicating uncus herniation through the tentorial incisura may explain confusing, bizarre neurological signs, *e.g.*, unilateral or bilateral sixth nerve palsy, ipsilateral paral-

ysis, anisocoria, etc. (17-19) (Fig. 16).

Fractional pneumoencephalography in most cases provides much better visualization of the aqueduct and fourth ventricle than does ventriculography, thereby eliminating the need for body-section radiography and special maneuvers of the head (Figs. 18 and 19). Furthermore, since gas frequently flows more readily from the

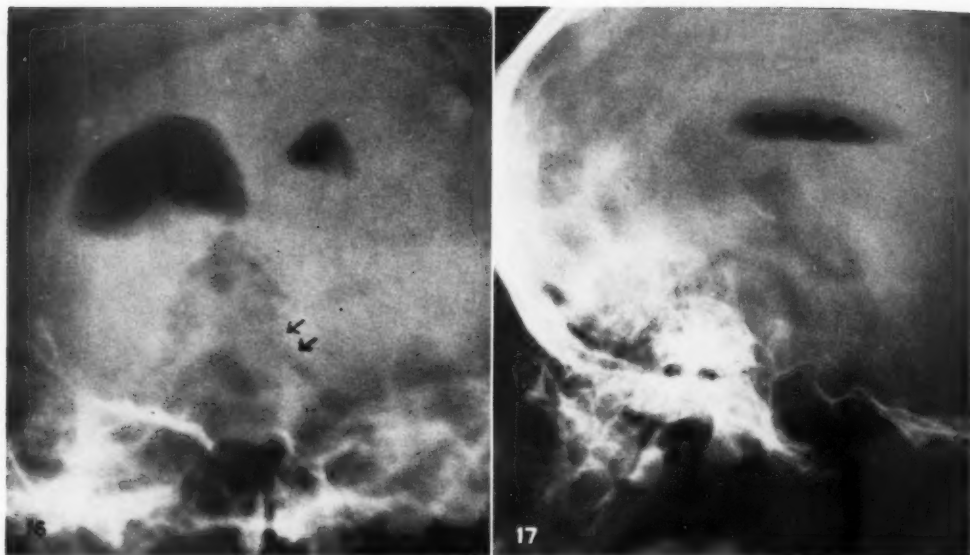


Fig. 16. Pneumoencephalogram (PA) of a left temporal lobe tumor with displacement and distortion of the left crural cistern (arrows) due to uncus herniation. Courtesy Dr. H. M. Wilson.

Fig. 17. Herniation of the cerebellar tonsils (arrow) in a patient with syringobulbia. Courtesy Dr. R. M. Lowman.



Fig. 18. Lateral pneumoencephalogram (10 c.c.) showing posterior displacement of the aqueduct and fourth ventricle by a metastatic tumor of the pons and cerebellum. Courtesy Dr. A. Kummer.

Fig. 19. Postero-anterior upright pneumoencephalogram (8 c.c.) showing lateral displacement of the aqueduct and fourth ventricle by a metastatic tumor of the right cerebellar hemisphere.

third ventricle into the lateral ventricles than in the reverse direction, controlled pneumoencephalography may facilitate the accurate diagnosis of obstructive lesions in the region of the anterior portion of the third ventricle.

At this point, it should be emphasized

that pneumoencephalography fails in 5 to 10 per cent of cases. A small fraction of these failures are due to various minor anatomical abnormalities of the cisterna magna, *e.g.*, absence of a well defined great cistern, adhesion of the pia arachnoid posteriorly, etc. If one excludes these

anomalies and improper technic, unsuccessful ventricular filling, in our experience, is usually due to an obstruction to the upward flow of gas. This is particularly true in patients with increased intracranial pressure. In the latter group, one should not persist in repeating the pneumoencephalographic examination. This, in our

## SUMMARY

1. The technic of controlled pneumoencephalography using small amounts of air has been reviewed. It is stressed that this is the technic of choice when cerebral pneumography is indicated.

2. There are instances where large amounts of air are desirable, *e.g.*, atrophy.

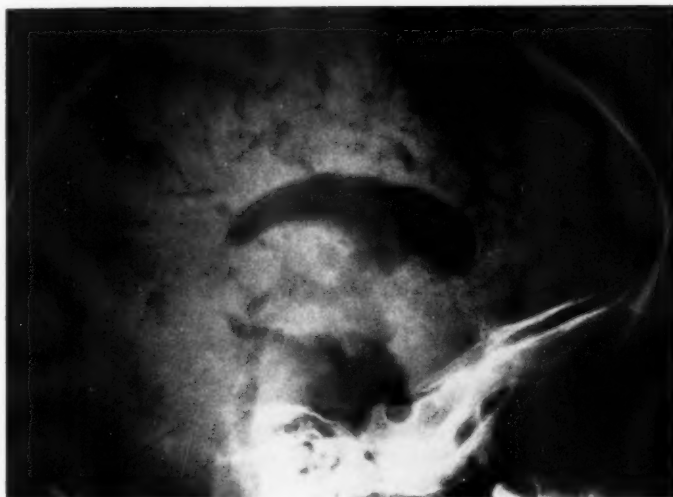


Fig. 20. Larger amount of air used in a patient with cerebral atrophy (60 c.c.).

opinion, is the prime indication for ventriculography. It has been our general experience in these cases that if pneumoencephalography is unsuccessful the first time, it is not likely to be successful a second time. Furthermore, it is our impression that stubborn persistence may lead to unfortunate complications. On the other hand, with proper care and judgment complications are uncommon.

As a safety measure, in patients with increased intracranial pressure, burr holes should be made prior to pneumoencephalography. Thus, if it becomes necessary to do a ventricular puncture, no time is lost.

There are, of course, occasions, *e.g.*, suspected atrophic lesions, and particularly diffuse atrophy, where small amounts of air are not only inadequate but may actually be misleading. In these cases, large amounts of air are employed (Fig. 20).

3. Ventriculography is reserved for those patients in whom pneumoencephalography fails (10 per cent).

4. The anatomy of the subarachnoid cisterns is presented in brief to demonstrate the importance of the cisterns in early and accurate diagnosis of various lesions.

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## SUMMARIO IN INTERLINGUA

**Controlate Pneumoencephalographia Fractional Con Referentias Particular Al Technica E Al Anatomia Del Cisternas Subarachnoide**

Es describe un technica de controlate pneumoencephalographia fractional. Isto es considerate como le procedimento de election quando pneumographia cerebral es indicate. Le quantitate total de aere routinarimente empleate raramente excede 20 o 30 cm<sup>3</sup>. Plus grande quantitates es necessari pro lesiones atrophic. Iste technica provide un successose inflation ventricular in 90 pro cento del casos. Ventriculographia es reservate pro le resto.

Es sublineate le importantia del cisternas subarachnoide in le diagnose del varie lesiones intracranial. Un cognoscentia de lor anatomia normal rende possibile le recognition de deformitates cisternal e assi

facilita un precoce e accurate diagnose. Isto es ver particularmente (1) pro le diagnose differential de tumores del region sellar, (2) pro le differentiation de tumores del fossa posterior, e (3) pro le demonstration de herniation del tonsillas cerebellar e del pedunculos cerebral. In le majoritate del casos le pneumoencephalographia provide un melior visualisation del aqueducto e del quarte ventriculo que le ventriculographia e, proque le gas frequentemente flue plus facilmente ab le tertie ventriculo a in le ventriculos lateral que in le direction reverse, le technica pote facilitar un accurate diagnose de lesiones obstructive del portion anterior del tertie ventriculo.



# Staphylococcal Pneumonia in Children and Adults<sup>1</sup>

HARVEY I. MEYERS, M.D., and GEORGE JACOBSON, M.D.

SINCE 1950, 76 proved cases of pneumonia due to *Staphylococcus aureus* have been seen at the Los Angeles County Hospital. There has been a considerable increase in the incidence of this type of pneumonia beginning in 1954 and reaching a peak in 1956, with 21 cases. Nineteen cases were seen in the first half of 1958. The incidence by years was as follows:

1950.....	1
1951.....	1
1952.....	2
1953.....	1
1954.....	7
1955.....	8
1956.....	21
1957.....	16
1958.....	19 (first half)

Staphylococcal pneumonia has in the past been discussed as a complication of influenza (1). It is evident, however, that the process exists as a primary bronchogenic pneumonia, similar in its course of development to the other bacterial pneumonias. Rarely, in children, it occurs as a complication of such conditions as measles or chickenpox, or as a result of septicemia from staphylococcal infection elsewhere in the body. Its occurrence as a complication of other diseases is more common in adults (2). An association has been noted between staphylococcal pneumonia and cystic fibrosis of the pancreas (3). This association has not been found among our cases.

In this series (Table I) there were 50 patients under fifteen years of age, and 23 of these, almost one-half, were less than six months of age. Thirteen deaths were recorded in the age group under fifteen, and all but one of these occurred before the age of six months. The exception was a nine-year-old girl who had a fulminating infection and died within forty-

TABLE I: AGE INCIDENCE AND MORTALITY IN 76 CASES OF STAPHYLOCOCCAL PNEUMONIA

	Age Incidence	Age Mortality
0-6 months	23	12
6 months-2 years	15	0
2-10 years	9	1
10-15 years	3	0
15-40 years	11	0
40 years and over	15	3
TOTAL	76	16

eight hours of entry. It is evident, therefore, that the mortality in staphylococcal pneumonia in children is almost confined to the age group under six months and that the mortality rate in this group is just over 50 per cent.

This last figure is one which offers a challenge both to the pediatrician and the radiologist. The only way that the mortality can be reduced is by the earliest possible institution of proper therapy. The radiologist's role in achieving this consists in making both an anatomical and etiological diagnosis. This is usually possible before the results of bacteriological studies are available to the clinician.

## ROENTGENOLOGIC PICTURE

The roentgenologic findings (4-6) in staphylococcal pneumonia serve to distinguish it from other types of pneumonia, especially in infants and small children. In adults the distinctive features seen in childhood are less commonly found and the etiologic diagnosis, therefore, is usually not so readily obtainable roentgenologically.

One of the most striking characteristics of the disease is the rapid change in the roentgen findings. The picture may change from one of minimal to very extensive involvement in a matter of hours. There is far from complete correlation between the

<sup>1</sup> From the Departments of Radiology, School of Medicine, University of Southern California, and the Los Angeles County Hospital. Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16-20, 1958.



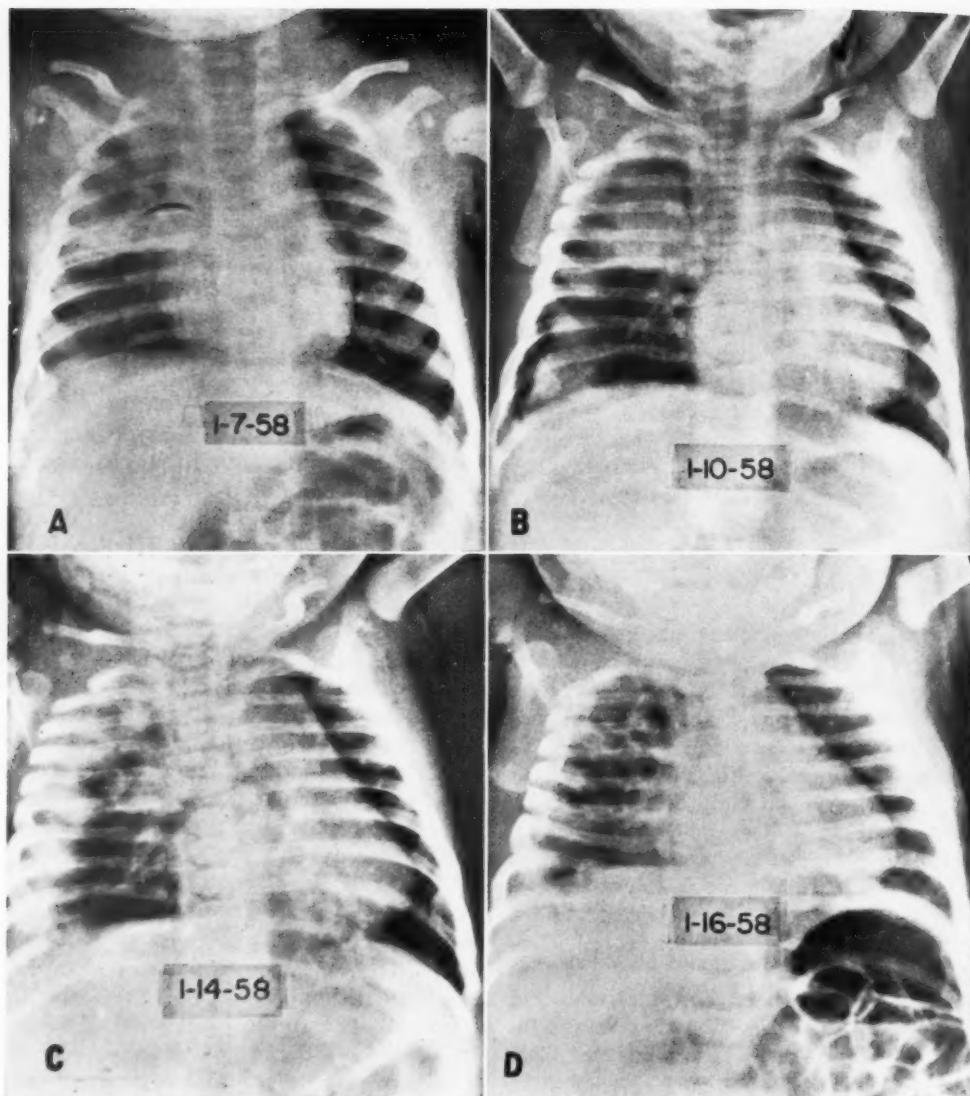


Fig. 1. A. Only infiltration is seen in the first roentgenogram of a three-month-old infant.  
B. Pneumothorax in addition.  
C. Empyema formation and pneumatoceles.  
D. Further development of pneumatoceles.

roentgenologic appearance and the clinical condition of the patient.

The feature of least value in differentiating staphylococcal pneumonia from other types of the disease is the pneumonic infiltration. While this may be lobar or segmental in distribution, it has no distinguishing characteristics (Fig. 1). In

addition, it may represent only a small portion of the visible findings, and in many cases may be entirely obscured by other changes. Rarely, the infiltration is bilateral.

Pleural effusion or empyema is a common—indeed, almost universal—occurrence, and its presence in a young infant

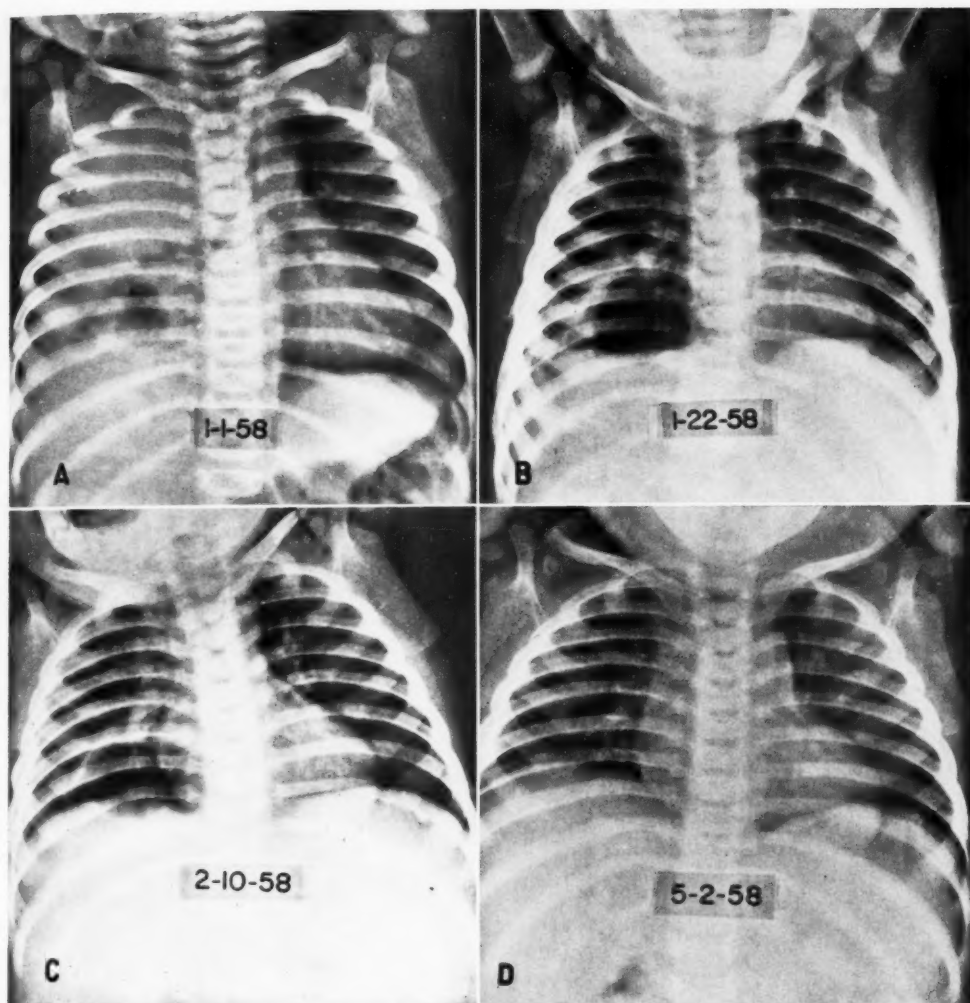


Fig. 2. A. Massive empyema as initial finding in child of seven months.  
B. Formation of a large persistent pneumatocele.  
C and D. Eventual disappearance of roentgen changes.

is nearly pathognomonic. Effusion or empyema may occur in pneumococcal or streptococcal pneumonia, but we have not seen it, perhaps because in these cases the response of the organisms to the commonly used antibiotics is so rapid. Effusion may not be demonstrable on the initial examination but is usually present subsequently. The rapidity and extent of its development may be astonishing. Not infrequently, empyema is seen in the first chest roentgenogram. It may be so ex-

tensive as to obscure everything else in the involved hemithorax (Fig. 2).

Pneumatocele formation is a regular feature in staphylococcal pneumonia and is quite diagnostic (Figs. 1 and 2). Pneumatoceles are thin-walled cyst-like areas which may or may not contain air-fluid levels. They tend to appear later in the course of the disease, but when they are seen early they give a very accurate indication of the nature of the illness. They are differentiated from lung abscesses by

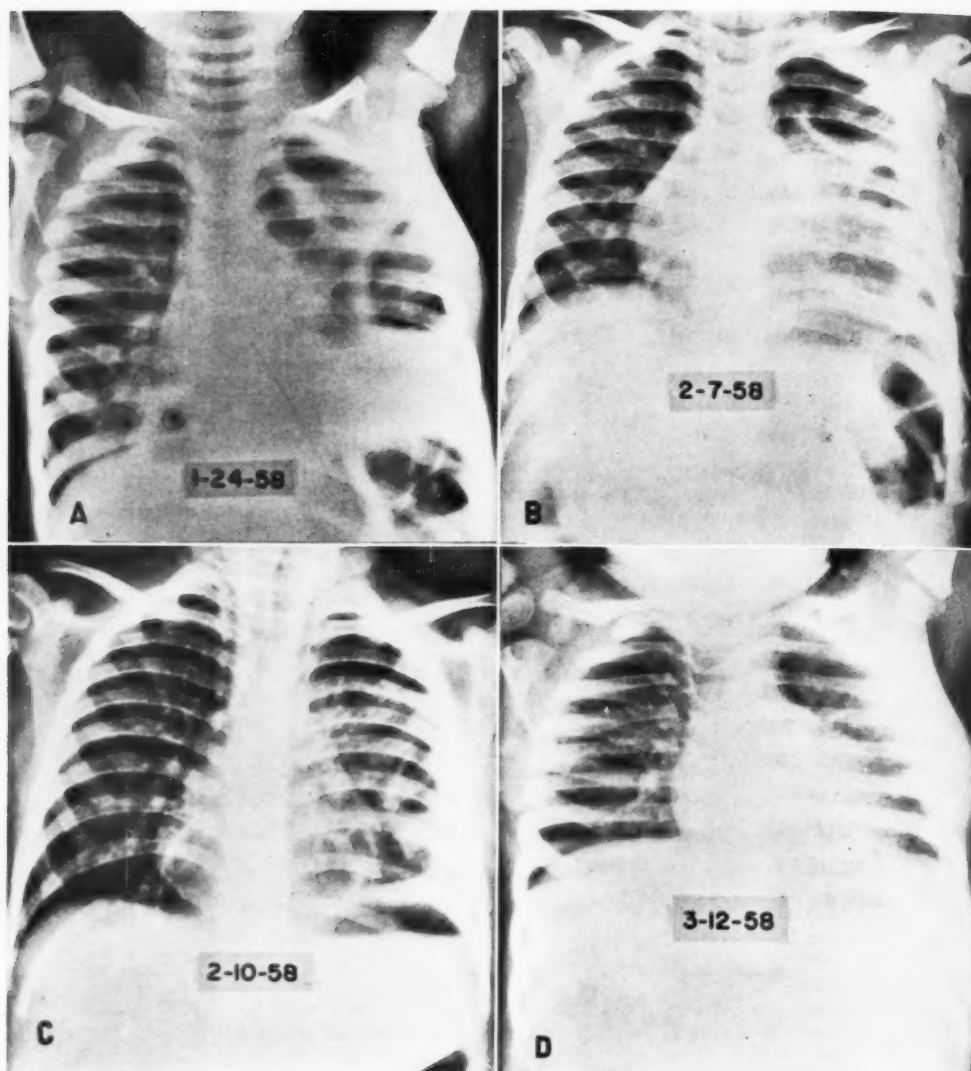


Fig. 3. A. Bilateral pneumatoceles plus other large air collections, possibly loculated pneumothorax.  
B. Slight improvement.  
C. Considerable change in three days.  
D. Pneumatoceles have disappeared. Persistence of slight pleural residua.

their thin walls and their tendency to rapid change in appearance, size, and location. Little correlation is noted between the presence and number of pneumatoceles and the clinical condition. Pneumatoceles may disappear after brief periods or they may persist for several months (Fig. 2). Eventually they disappear completely.

Another characteristic finding in staphylococcal pneumonia is pneumothorax or, perhaps more accurately, pyopneumothorax. This is quite variable in extent, ranging from small, sometimes loculated areas, which may be hard to distinguish from pneumatoceles (Fig. 3), to massive tension pneumothorax. The latter results from bronchopleural fistula formation and

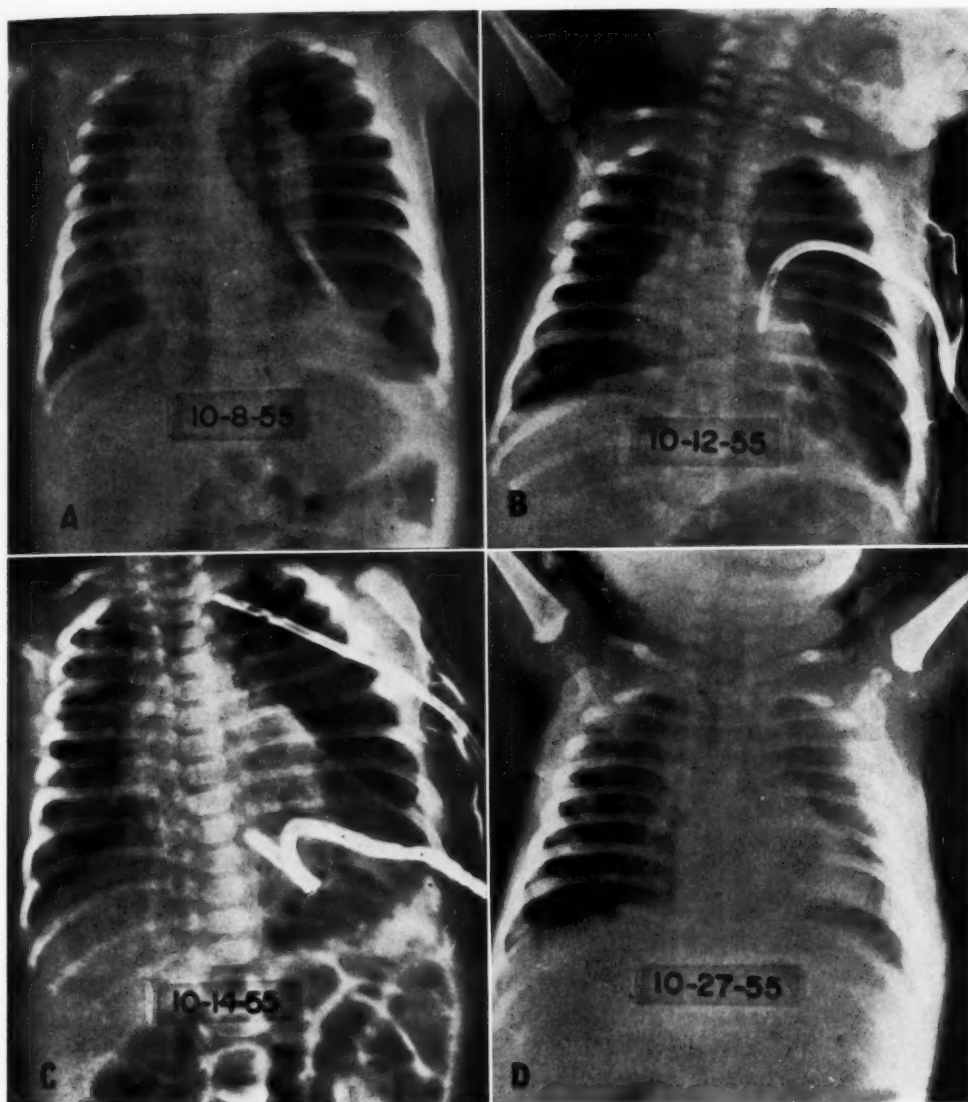


Fig. 4. A. Tension pneumothorax seen in infant of seven weeks on admission.  
B and C. Failure of lung to expand despite continuous pleural suction.  
D. After resection of left lower lobe for large bronchopleural fistula.

can be a very alarming complication (Fig. 4). Bilateral pneumothorax occurs rarely. There was one such case in this series, in a three-week-old infant, who survived.

While the features listed above are seen regularly in children, the picture in adults is by no means so clear-cut. In the older group infiltration is a more prominent

feature, partly because empyema is less common and, when it does occur, is less extensive and therefore less likely to obscure the parenchymal findings. Pneumatocoles also are less frequently present. On the other hand, true lung abscesses are seen much more commonly than in children. Pneumothorax was not encountered

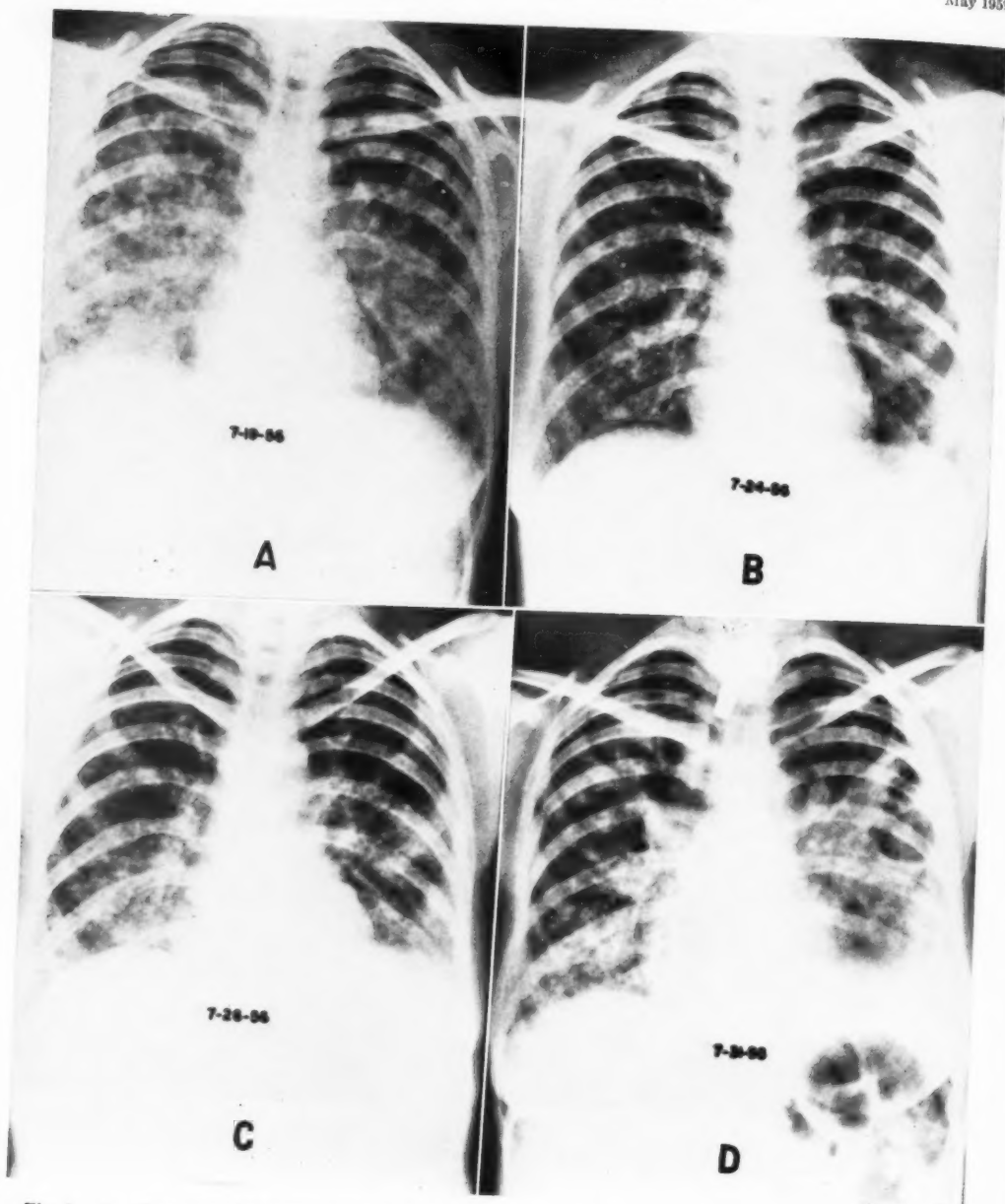


Fig. 5. A. Extensive chickenpox pneumonia in a 28-year-old woman.  
B. Improvement with cortisone therapy.  
C. New infiltration has appeared in left lower lobe.  
D. Infiltrations, pneumatoceles, and empyema now present.

in any of the adult patients in this series. Although the great majority of adult patients do not exhibit the characteristic findings seen in young children, in occa-

sional cases the features listed above, with the exception of pneumothorax, are found. When they are present, the diagnosis is suggested.



## TREATMENT

The basic treatment of staphylococcal pneumonia depends on isolation of the organism by culture, and administration of the correct antibiotics as determined by antibiotic sensitivities. For the last few years almost none of our cases has yielded organisms sensitive to penicillin, and almost all have been resistant to the tetracyclines as well. Most of the organisms in patients that were successfully treated were sensitive to chloramphenicol, erythromycin, or bacitracin. Besides chemotherapy and general supportive measures, such as oxygen, blood transfusions, etc., closed thoracotomy with insertion of an indwelling catheter into the pleural space, with constant suction, is frequently necessary and is often an immediate life-saving measure. In general, this is required for either empyema or pneumothorax. For the past several years streptokinase and streptodornase have been used to irrigate the pleural space *via* the catheter.

The course of the disease is frequently prolonged, often requiring two months of active treatment. Relapses were formerly more common than at present because of the earlier tendency to stop treatment too soon.

Those infants and children that recover usually have no parenchymal findings after

about three months, although pleural thickening may persist for some time.

## CONCLUSIONS

Staphylococcal pneumonia has become an increasing problem in children, particularly in infants under six months of age, in whom the largest number of cases occur, and in whom the mortality rate is over 50 per cent. The roentgenologic picture is usually characteristic enough to suggest an exact etiological diagnosis early in the course of the disease. It is hoped that this will lead to earlier institution of proper therapy, with more favorable results.

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## SUMMARIO IN INTERLINGUA

## Pneumonia Staphylococcal In Patientes Pediatric E In Adultos

Septanta-sex provate casos de pneumonia staphylococcal esseva vidite in le Hospital del Contato Los Angeles ab 1950 usque al prime medietate de 1958. De iste casos, 23 occurreva in infantes de minus que sex menses de etate con un mortalitate de plus que 50 pro cento. Significative tractos roentgenographic es le rapide alteration del constatationes, le presentia de effusion pleural o empyema, le formation de pneumatocele, e pyopneumothorace de

extension variabile. In patientes de etate plus avantiate, le constatationes es minus clar: le infiltration es un tracto plus prominente.

Le curso del morbo es prolongate. Le tractamento es basate super le isolation del organismo e le administration del appropriate antibioticos. Le radiologo frequentemente pote suggerer le diagnose ante que le resultados del studios bacteriologic es disponibile al medico clinic.

# The Bone Lesions of Childhood Leukemia

## A Survey of 140 Cases<sup>1</sup>

JAMES K. V. WILLSON, M.D.

THE BONE CHANGES of childhood leukemia, present in about two-thirds of cases, are often of value for differentiation when the clinical diagnosis is obscure. Although the bone lesions are not specific for this disease, except perhaps in the late stages, they are of significance in that similar lesions are not usually associated with the diseases which leukemia most often resembles clinically. The transverse line of radiolucency beneath the metaphyses of the long bones, the earliest and most common manifestation of bone involvement in leukemia, is rare in other diseases of children over the age of two years. The extensive destructive lesions in the long bones occurring late in the disease present a characteristic pattern not seen in other conditions, except perhaps metastatic neuroblastoma. Earlier stages of destruction, periosteal reaction, and osteosclerosis are other changes which may be present in a recognizable pattern, or may give a clue as to the diagnosis when interpreted in the light of the clinical findings.

For many years, since about 1932, it has been the practice in the Harriet Lane Home of The Johns Hopkins Hospital to include roentgenographic examination of the long bones in the study of cases of suspected leukemia when the diagnosis was not certain clinically. Often such studies have served simply to confirm a suspected diagnosis. Occasionally, however, they have been sufficiently important to be the prime factor in establishing the nature of the disease.

The present study was undertaken to investigate the diagnostic value of lesions of the long bones in leukemia. Long-bone examinations in 140 proved cases available in the Pediatric Division of the

Department of Radiology of this institution were reviewed. The general incidence in other diseases of one of the important leukemia lesions, namely the transverse line of radiolucency beneath the metaphysis, was also investigated. Finally, the bone lesions of leukemia, generally, were compared with long-bone lesions in those diseases which leukemia most often resembles clinically.

### REVIEW OF THE LITERATURE

Kalayjian, Herbut, and Erf (10), in 1946, collected from the literature 144 cases of childhood leukemia with long-bone lesions, mostly isolated case reports. To these they added 2 cases of their own. They divided the lesions into four types: (a) a transverse line of radiolucency beneath the metaphyses of the long bones; (b) osteolytic destructive lesions; (c) periosteal reaction; (d) osteosclerosis. Others have given similar descriptions (17). Baty and Vogt (1) first described the radiolucent metaphyseal line in 1935. They found it to be the most common bone change, present in 70 per cent of their series of 43 cases. Silverman (14), in 1948, reported a series of 103 cases, the largest previously presented, with a detailed review of the literature. The average incidence of roentgenologically demonstrable bone involvement in his series was 51 per cent. Three other series of 38 (12), 40 (4), and 70 (18) cases have been reported. In these the average incidence of bone disease was approximately 75 per cent. The difference between this latter figure and that of Silverman appears to be due primarily to the fact that Silverman found the transverse radiolucent metaphyseal line in only 14 per cent of his series, while the others

<sup>1</sup> From the Department of Radiology, The Johns Hopkins Hospital, Baltimore, Md. Accepted for publication in August 1958.

tended to agree with Baty and Vogt that this was the most common lesion, present in about 70 per cent of cases. In general, all reports were in agreement in their descriptions of the types of bone pathology manifested roentgenologically.

#### PRESENTATION OF DATA

Included in this series are all cases of leukemia seen in the Harriet Lane Home with proof of the diagnosis by blood smear, marrow biopsy, or autopsy, and satisfactory x-ray examinations of the long bones. The age range was from less than six months up to thirteen years. Not all cases of leukemia seen in the clinic are included because often, when the diagnosis is apparent clinically, x-ray examinations are not done. Only suspected cases or cases yet unproved are usually studied roentgenologically. It is this group which largely comprises this series. A total of 140 cases were available for review.

Clinically the findings conformed to those previously reported by other workers. Fever, listlessness, and pallor were common presenting symptoms. Many patients were first seen with a febrile illness, often an upper respiratory infection. Another common picture consisted of easy fatigability, loss of appetite, and irritability. Hemorrhagic tendencies, bone and joint pain, and lymph node enlargement were frequently seen.

The sex and age distribution did not differ from most previous reports (4, 13, 14). The peak incidence was between two and five years, this group accounting for 73 cases (52 per cent). Only 13 cases (9 per cent) occurred before the age of two years. There was a preponderance of white patients (90 per cent) over Negroes (10 per cent), although the Negro group makes up well over 50 per cent of the patients seen in this clinic. No explanation for this difference was found. These data are summarized in Table I.

There was no correlation between the presence of bone lesions and age, sex, race, or cell type. In general there was a correlation between duration of disease

TABLE I: AGE, SEX, AND RACE INCIDENCE IN 140 PROVED CASES OF LEUKEMIA

	No. of Cases	Per cent
Age		
0-6 months.....	3	2
6-12 months.....	1	1
1-2 years.....	9	6
2-5 years.....	73	52
5-10 years.....	43	31
10-13 years.....	11	8
Sex		
Male.....	89	64
Female.....	51	36
Race		
White.....	126	90
Negro.....	14	10

and bone changes, but exceptions were not uncommon. Many cases of as little as one month duration or less showed bone involvement, at times advanced, while in a few cases of six to nine months duration the bones were normal. Reversibility of the bone lesions under therapy with the folic acid antagonists was sometimes observed. In a number of cases sclerotic changes at the distal ends of the bones developed after treatment, similar to changes previously reported by other workers (11, 13).

#### ROENTGENOLOGIC MANIFESTATIONS IN THE LONG BONES

*General Considerations:* The incidence of all bone lesions was 64 per cent, or 89 of 140 cases. The most common manifestation was a transverse line of radiolucency at the ends of the long bones, present in 76 cases (53 per cent). Next were osteolytic lesions, in 53 cases (38 per cent), and in third place periosteal reaction, in 27 cases (19 per cent). Osteosclerosis was not observed. The changes showed a predilection for the areas of most rapid bone growth. Almost invariably when lesions were present, there was involvement at the knee. The wrists and ankles were involved almost as frequently, but the elbow only infrequently, while changes in the shoulder and hip were rare except in advanced cases. One would expect early lesions at the upper end of the humerus, since this is one of the sites of most rapid bone growth (2). Failure to observe the early transverse



Fig. 1. The metaphyseal radiolucent line of leukemia, usually the earliest bone manifestation. Over the age of two years, it is common in leukemia and rare in other diseases.

A. Narrow line. Leukemia of three months duration. Age of patient three and a half years.  
 B. Wide line. Atypical febrile illness of three months duration. Age of patient five years. When this examination was done, a clinical diagnosis had not been established. A radiological diagnosis of leukemia was subsequently confirmed by sternal marrow biopsy.

radiolucent line there can perhaps be accounted for by the fact that the concave metaphysis of the upper humerus may well obscure this change. In any event, the most suitable places to observe the earliest changes radiologically are the knees and wrists.

*The Radiolucent Metaphyseal Line:* A narrow zone of decreased density 1 to 6 mm. in width, just beneath the metaphysis, was the most common finding observed (Fig. 1), being encountered in 76 cases (53 per cent). It was the only change in 22 per cent and was present with other lesions in 31 per cent. Characteristically this line exhibits a well defined, proximal margin but without so-called "pencilled-in" sharpness. It appears somewhat as if a zone of bone had been erased beneath a thin metaphyseal shell. The lateral cortical margins and the metaphyseal plate usually are intact, a point of differentiation from scurvy. This feature showed no age selectivity. It occurred with an age distribution corresponding to that of the disease itself.

*Osteolytic Lesions:* The next most common lesion was an osteolytic destructive process of varying degree, present in 53 cases (38 per cent). This appeared first in the spongiosa of the long bones and often showed symmetrical involvement on the two sides. With progression of the disease, destruction extends down into the shafts of the bones and may involve the round bones of the ankles and wrists, and the tubular bones of the hands and feet, as well as the axial skeleton.

For convenience the destructive lesions may be divided into three subtypes: (a) multiple punctate radiolucencies (Fig. 2); (b) a decalcification of the metaphysis (Fig. 3); (c) frank destruction (Fig. 4). The punctate radiolucencies range from a coarsened trabecular pattern to definite small multiple punched-out lesions. The metaphyseal decalcification manifests itself as a diffuse decreased density in the spongiosa, often with a sharp line of demarcation from the shaft of the bone. In some cases it may appear as if the transverse line of radiolucency at the



Fig. 2. Osteolytic lesion of leukemia, subtype 1: multiple, punctate radiolucencies. This type of bone change varies from a coarsened trabecular pattern, as in this example, to multiple small punched-out lesions.

metaphysis has expanded to include all the spongiosa. In other cases, the two lesions may be present together. The frankly destructive lesions present a variety of forms. There may be a single, small, localized lesion, multiple discrete lesions, or generalized bone destruction. Usually these lesions involve the spongiosa initially. Rarely, generalized osteolytic destruction is seen in the shafts, with little change in the spongiosa. This occurred in one case of this series.

**Periosteal Reaction:** Periosteal elevation along the shafts of the long bones (Fig. 5) was evident in 27 cases (19 per cent). In 3 cases it was the only change, and in 1 of these there was multiple layering. In 24 others, periosteal reaction occurred in association with other manifestations.

Pathological fractures were present in 3 cases. In all 3, they consisted of infarctions at the ends of the bones associated with advanced destructive disease.



Fig. 3. Osteolytic lesion of leukemia, subtype 2: decalcified metaphysis. Note relatively sharp demarcation at junction of metaphysis and shaft.



Fig. 4. Osteolytic lesion of leukemia, subtype 3: frank destruction. A single discrete destructive lesion may occur, as illustrated here, or there may be multiple lesions in many bones. Typically, the changes appear first in the spongiosa of the long bones; often they are bilaterally symmetrical.

Osteosclerosis was not observed in this series; nor was osteoporosis except that caused by advancing destructive lesions.





Fig. 5. Advanced bone lesions of leukemia in a child of two years, with symptoms for four months. Note the severe periosteal reaction, the infractions of the cortex at the ends of the bones, the marked decalcification of the metaphyses, and the destructive lesions extending into the shafts. In general, the advanced stages of bone destruction of leukemia resemble no other disease except metastatic neuroblastoma.

#### OTHER ROENTGENOLOGIC MANIFESTATIONS

Frequently, enlargement of the liver and spleen may be observed, and often may be seen on postero-anterior chest films. Pulmonary infiltration may be seen following secondary infection or hemor-

rhage in the lungs. Occasionally enlarged lymph nodes may be detected. According to Gowdey and Neuhauser (8) leukemic infiltration of the kidneys is common and may present a characteristic pyelogram.

#### PATHOLOGIC CONSIDERATIONS OF THE BONE LESIONS

Follis and Park (7) reported the pathological findings in a group of patients from this institution. Erb (6) and others (14) have also studied the pathology of leukemic bone lesions. Three factors operate in the production of the destructive lesions: a general interference with nutrition, pressure of the proliferating leukemic cells, and stimulation of osteolytic activity by the leukemic cells. The transverse band of radiolucency is probably the result of a combination of generalized interference with nutrition and the effects of the proliferating leukemic cells. Osteolytic activity associated with the leukemic cells has been demonstrated histologically. The nutritional factor as an etiologic agent is supported by the fact that a similar lesion is found in several other diseases of early infancy, a period during which bones respond rapidly to systemic influences, and occasionally in older children who are chronically ill with diseases other than leukemia. The common occurrence of the transverse radiolucent line in leukemia and its rarity in other diseases may be accounted for by the relative severity of the effects of leukemia and the rapidity with which chronic manifestations develop in this disease.

The periosteal reaction is the result of leukemic infiltration between the periosteum and the cortex. The phenomenon of layering is caused by new bone formation beneath the elevated periosteum. The osteoblastic changes that have been reported (19) are the result of stimulation of the osteoblasts by the leukemic cells.

#### DIFFERENTIAL DIAGNOSIS

When the bone lesions of leukemia are advanced, their appearance is usually



Fig. 6. Neuroblastoma, advanced metastatic destruction, indistinguishable from advanced bone destruction of leukemia. Clinically, however, the differentiation at this stage is usually clear.



Fig. 7. The nonspecific metaphyseal line of radiolucency of infancy. Below the age of two years this lesion may be seen in practically any chronic or severe illness. Leukemia in this age group is uncommon (10 per cent of cases).

characteristic, and is mimicked only by advanced metastatic neuroblastoma (Fig. 5). In such a case, however, the clinical differentiation is usually quite clear. To compare the two diseases radiologically, a group of 30 unselected cases of proved neuroblastoma with long-bone roentgenograms were reviewed. About one-third were normal and two-thirds showed varying degrees of osteolytic destruction. In none was a radiolucent line demonstrable at the metaphysis. In fact, it was not uncommon to observe increased density of the metaphyses, sometimes as marked as that seen in lead poisoning. In the absence of the radiolucent metaphyseal

line, the destructive lesions in the long bones of the two diseases are indistinguishable (Fig. 6). Neuroblastoma exhibited a tendency to involve the pelvis and femora relatively early, while leukemia involves these bones only in the late stages. Conversely, changes in the tubular bones of the hands and feet, frequently seen in leukemia, were unusual in neuroblastoma.

In the intermediate stages of bone involvement, the presence of a combination of the transverse line of radiolucency at the metaphyses and destructive lesions in the distal ends of the long bones is usually diagnostic of leukemia.

Often the presence alone of the transverse line of radiolucency at the metaphyses may suggest the diagnosis of leukemia when the clinical findings are taken into consideration. Baty and Vogt (1) compared the line to the rarefied zone of scurvy. Other manifestations, however, usually differentiate these diseases without difficulty. Baty and Vogt also

reported a similar line in a three-year-old child with *Streptococcus meningitis* and a four-year-old child with a cerebellar tumor. Silverman (14) observed transverse bands of diminished density in two children with bacteremia, a twenty-seven-month-old boy with disseminated tuberculosis and a twenty-two-month-old child with agranulocytosis. Dale (4) and Janus (9) noted similar radiolucent lines in various diseases of infancy (Fig. 7).

To evaluate the general incidence of the transverse line of radiolucency, all long-bone roentgenograms obtained during one calendar year were reviewed. Among 740 patients with long-bone films, 32, other than those with leukemia, showed transverse radiolucent lines at the metaphyses (Fig. 8). Four of the number were two years old or older. Among the cases were cerebellar neoplasm, brain abscess, postencephalitic changes, and healing rickets. None of these resembled leukemia clinically. Twenty-eight patients were below the age of two years. Congenital syphilis, scurvy, and healing rickets accounted for 10 cases. Cretinism, pontine angle tumor, celiac disease, and adrenal hyperplasia were also seen, but here again there was no resemblance to leukemia clinically. There were, however, 5 cases of infection in the group below two years which, early in their course, exhibited both a clinical resemblance to leukemia and a transverse radiolucent metaphyseal line. Three were cases of septicemia; one was a *Streptococcus* arthritis, and the other encephalitis. The clinical resemblance to leukemia usually occurred early in the disease while the radiologic resemblance occurred late. It is apparent, however, that in any given case of this type in this age group, the finding of a transverse radiolucent line would be of little value.

A study was also made of the bone films from those cases which most often resemble leukemia clinically, namely, rheumatoid arthritis, anemia, rheumatic fever, and infectious mononucleosis (4, 13-15). Long bone examinations are not usually made in the latter two diseases. All the long-bone

roentgenograms over a five-year period in cases with a proved diagnosis of rheumatoid arthritis or anemia were reviewed. There were 25 cases of rheumatoid arthritis and 20 anemias of various types. None showed transverse lines of radiolucency or other changes resembling leukemia. In 1 case of rheumatoid arthritis multiple growth lines were demonstrated at the ends of the long bones (Fig. 8,C). These may occur in almost any disease including leukemia, and occasionally there may be a resemblance to the radiolucent line of leukemia.

It is apparent that below the age of two years the transverse line of radiolucency is indeed a nonspecific finding. It may be observed not only in diseases which are unlike leukemia clinically but also in various infections which may resemble leukemia. Above the age of two years, however, when about 90 per cent of the cases of leukemia occur, the transverse line of radiolucency is rarely seen in any other disease. In the light of these findings, this feature takes on added significance. When it is present in a patient over the age of two years, leukemia must certainly be excluded. When leukemia is suspected, long-bone roentgenograms should be obtained.

#### SUMMARY AND CONCLUSIONS

1. Long-bone roentgen examinations in 140 cases of childhood leukemia were reviewed. The most common abnormal finding was a transverse radiolucent line at the metaphyses of the long bones. Osteolytic destructive lesions and periosteal reaction were also observed.

2. The bone lesions of leukemia were compared with the bone lesions observed in 30 unselected cases of neuroblastoma, which may resemble leukemia radiologically, and with those in 25 cases of rheumatoid arthritis and 20 cases of anemia, which may bear a clinical resemblance to leukemia.

3. The occurrence of the transverse radiolucent line at the metaphysis in diseases other than leukemia was in-

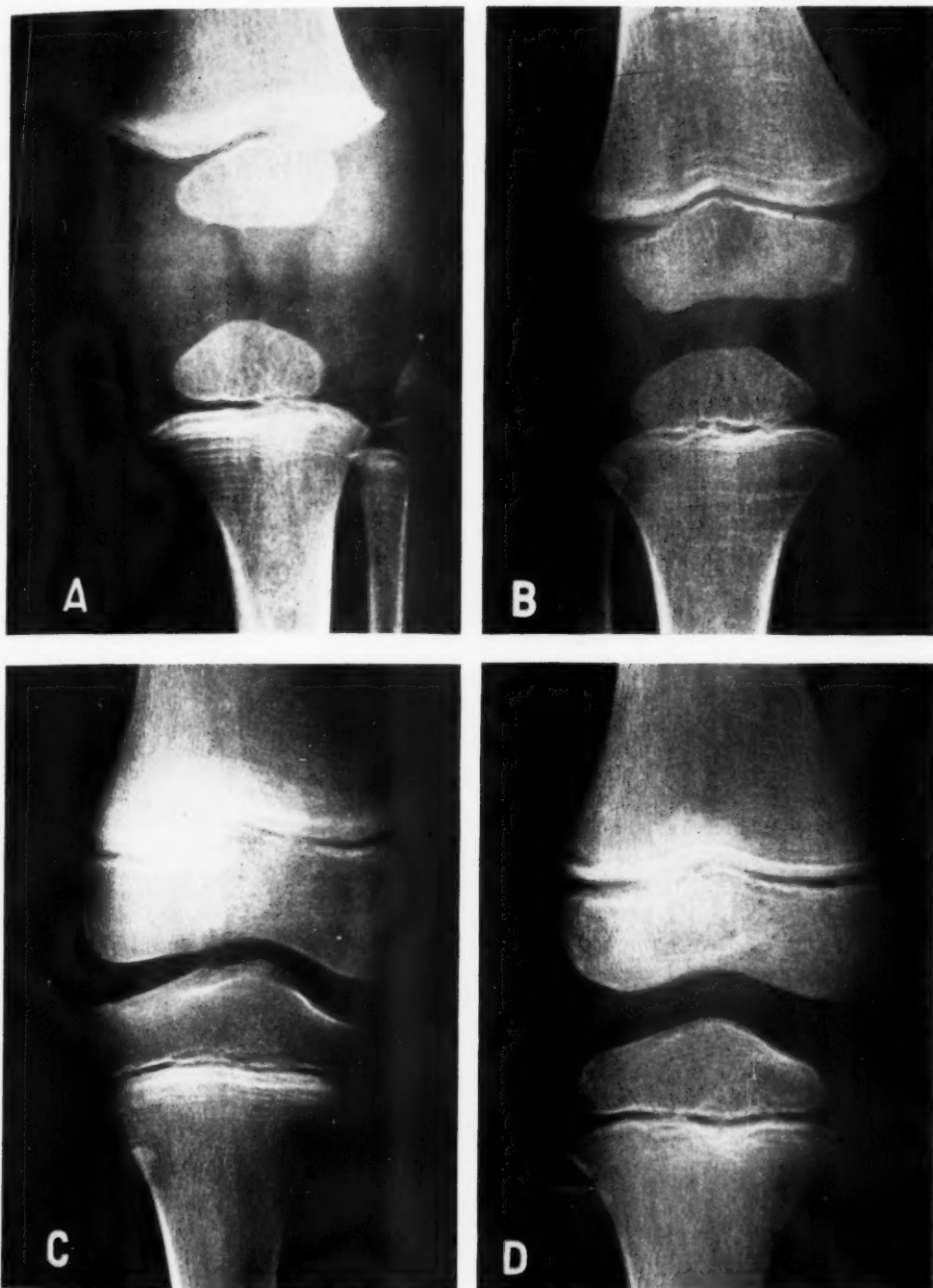


Fig. 8. Metaphyseal radiolucent lines in diseases other than leukemia. Over the age of two years, this finding is rare except in leukemia. Clinical differentiation is usually apparent, except for some chronic infections.

- A. Age sixteen months. Diagnosis: Streptococcus arthritis.
- B. Age two years. Diagnosis: Cerebellar tumor.
- C. Age seven years. Diagnosis: Rheumatoid arthritis. There is an apparent radiolucent line actually due to multiple dense growth lines. This is an atypical finding of rheumatoid arthritis, present in 1 of 25 consecutive cases reviewed.
- D. Age five years. Diagnosis: Encephalitis.

vestigated by a review of 740 consecutive long-bone examinations, comprising all such studies made during one calendar year in the pediatric division of the Department of Radiology of the Johns Hopkins Hospital. This lesion was observed in 28 patients below the age of two years and in 4 patients over that age.

4. The conclusion is offered that the presence of a radiolucent metaphyseal line in a child over the age of two years may be of significance in the diagnosis of leukemia. It was not observed in neuroblastoma, rheumatoid arthritis, or the anemias. Below the age of two years this lesion may occur in association with many chronic diseases.

5. The advanced destructive lesions of leukemia present a characteristic pattern, unlike that in other diseases except metastatic neuroblastoma. Clinically the differential diagnosis from this latter condition is usually clear. Radiologically, the presence of a transverse radiolucent metaphyseal line associated with destructive lesions is in general indicative of leukemia, as this line is not observed in neuroblastoma.

6. When leukemia is suspected, yet unproved, roentgenograms of the long bones should be obtained.

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#### SUMMARY IN INTERLINGUA

#### Lesiones Ossee In Leucemia De Pueritia: Un Revista De 140 Casos

Esseva facite un revista del examines roentgenologic del ossos longe in 140 casos de leucemia de pueritia. Le plus frequente constatacion anormal esseva un transverse linea radioluciente al metaphyse del ossos longe. Lesiones destructive osteolytic e reaction periosteal esseva etiam observate.

Le lesiones ossee de leucemia esseva comparate con le lesiones ossee observate in 30 nonseligitte casos de neuroblastoma, le

qual — radiologicamente — pote resimilare leucemia, e con illos observate in 25 casos de arthritis rheumatoide e in 20 casos de anemia, le quales pote haber un resimilantia clinic con leucemia.

Le occurrentia del transverse linea radioluciente al metaphyse in morbos altere que leucemia esseva investigate per medio de un revista de 740 consecutive examines del ossos longe le quales comprendeva omne tal



studios facite durante un anno calendari in le division pediatric del Departamento de Radiologia al Hospital Johns Hopkins. Iste lesion esseva observate in le caso de 28 patientes infra le etate de duo annos e in 4 patientes supra ille etate.

Le conclusion es offerite que le presentia de un linea radioluciente metaphyseae in un subjecto supra le etate de duo annos pote esser significative in le diagnose de leucemia. Illo non esseva observate in casos de neuroblastoma, de arthritis rheumatoide, o del anemias. Infra le etate de duo annos iste lesion pote occurrer in association con multe morbos chronic.

Le avantiata lesiones destructive de leucemia presenta un configuration distinctive que non resimila illo de altere morbos con le exception de neuroblastoma metastatic. Clinicamente le diagnose differential inter iste condition e leucemia es generalmente clar. Radiologicamente le presentia de un transverse linea radioluciente metaphyseae in association con lesiones destructive es in general un indication de leucemia, proque iste linea non es observate in neuroblastoma.

Quando leucemia es suspicite sed non provate, roentgenogrammas del ossos longe debe esser executate.



## Subpleural Interlobular Lymphectasia Reflecting Metastatic Carcinoma<sup>1</sup>

BERTRAM LEVIN, M.D.<sup>2</sup>

SUBPLEURAL interlobular lymphatic dilatation was first described as a roentgenographic entity in 1951 by Kerley (5). The dilated lymphatics appear on the chest roentgenogram as short transverse lines in the bases of the lungs, 1 to 2 cm. long, extending outward to the pleura. They vary in number from few to many and are arranged in stepladder fashion. They are usually bilateral but occasionally unilateral and are generally confined to the lower half of the lung fields.

Kerley reported the occurrence of these lines in silicosis and attributed them to lymphectasia. They lay in relative obscurity for a time and a number of reports then appeared in rather rapid succession calling attention to their occurrence in mitral valve disease, the consensus being that in this association they reflect chronic pulmonary venous hypertension. They are only occasionally seen, however, in other forms of heart disease with attendant pulmonary hypertension.

Fleischner *et al.* (1) believed these lines to be due to hemosiderin deposition along the interlobular septa. The present author, in an earlier report on the subject (6), presented biopsy proof that the basal lines represent dilated subpleural lymphatics, as Kerley believed. Gough (2, 3), using paper-mounted lung sections, also demonstrated dilatation of the lymphatics in mitral stenosis. Though Kerley considered the horizontal lines too long to represent interlobular septa, Gough (3) indicated that they were shadows cast by these septa and their lymphatics. "When the interlobular septa are sufficiently parallel to the x-ray beam, and at the same time pathologically thickened. . . they will show up as lines. In the septa is one of the systems of lung lymphatics,

and Kerley is right in saying that these lymphatics are distended but the main bulk of excess fluid is in the connective tissue of the interlobular septa, which become widened."

According to Grainger and Hearn (4), dilated subpleural lymphatics may be seen in any condition with impaired pulmonary lymphatic drainage, such as lymphangitis carcinomatosa, Hodgkin's disease, leukemia, mediastinal sarcoidosis, and pneumoconiosis, as well as after ligation of the thoracic duct. In spite of this, the lines have become closely identified with mitral stenosis, many radiologists losing sight of the nonspecificity of this sign and of the fact that it may be of aid in diagnosing other than pulmonary hypertension secondary to heart disease.

The writer has seen basal interlobular septal widening occur acutely, coincident with the onset of a bronchopneumonia, and disappear just as suddenly with improvement of the pneumonia. This phenomenon is attributed to the sudden marked increase in transudate locally, and its drainage *via* the local lymphatics, including those in the interlobular septa. This is, however, an unusual radiologic finding in pneumonia.

The writer has encountered many cases of carcinomatous metastases in the lungs in which dilated basal lymphatics were a prominent roentgenologic feature. In some instances this finding was the first clue that a malignant lesion was present. Because it is felt that, in general, too little attention is paid to lymphatic dilatation as reflecting carcinomatous metastases, a small group of representative cases is presented to illustrate the roentgen appearance, though this does not differ from that in cases of other etiology.

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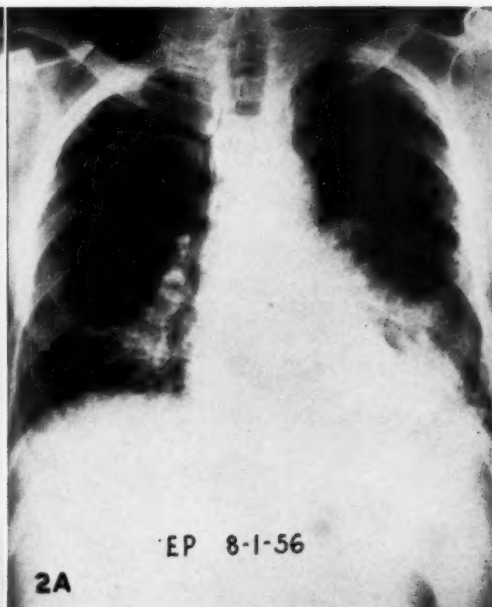


Fig. 1. Case I. Admission chest film showing bilateral basal pulmonary consolidation.  
 Fig. 2A. Case I. Chest film eleven days later revealing bilateral basal horizontal lines. Fluid has been withdrawn from the left pleural cavity.  
 Fig. 2B. Case I. Magnification of right lower lung field. The distended interlobular septa (basal horizontal lines) are well seen.  
 Fig. 3. Case I. Film made one week before death, showing increased distention of the interlobular septa. Those on the right are obscured by pleural effusion.

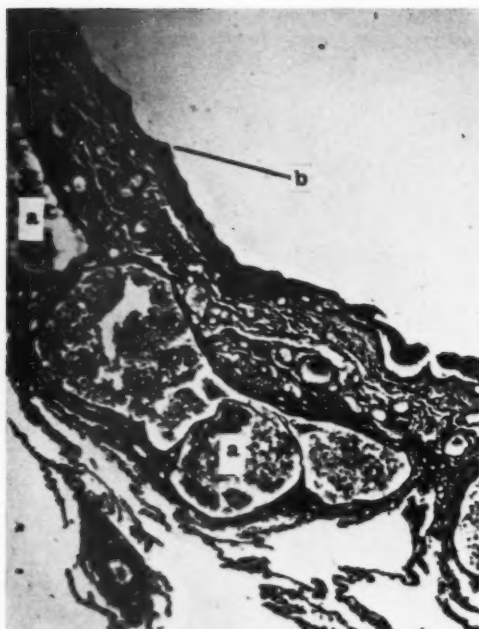


Fig. 4. Case I. Low power photomicrograph ( $\times 90$ ) of lung section. The subpleural lymphatics (a) are packed with and distended by tumor cells. b. Pleural surface (Gomori silver stain.)

#### CASE REPORTS

**CASE I:** E. P., a 55-year-old white male, had been in excellent health until four weeks prior to hospital admission. At that time he began to experience lassitude, anorexia, fatigability, and, finally, cough. He was placed on antibiotics, with some relief of symptoms, and four days later was hospitalized. He was afebrile, and positive physical findings were limited to the chest: percussion flatness over the left lung base posteriorly and crepitant râles in both bases.

The initial chest roentgenogram, made on the day of admission, showed bilateral basal consolidation thought to represent bilateral pneumonia (Fig. 1). There was minimal left pleural effusion. Active medical treatment resulted in no improvement clinically. A film made eleven days after the initial examination showed dilated basal subpleural lymphatics (Fig. 2). On the basis of this finding a diagnosis of lymphogenous dissemination of metastases was made, though this possibility had received little clinical consideration. Some days later block sections of aspirated pleural fluid revealed malignant tumor cells.

The patient deteriorated progressively and died approximately ten weeks later. Figure 3 is a chest film made about one week before death, showing increased lymphectasia. Postmortem examination revealed primary right renal carcinoma with ex-

tensive metastatic spread. Subpleural lymphatics were distended by tumor cells (Fig. 4).

**CASE II:** H. W., a 39-year-old white male, was admitted to the hospital because of intermittent fever, anorexia, weight loss, weakness, and night sweats. On admission the only relevant findings were fever and diminished breath sounds in both lung bases.

The patient was in the hospital for four months, during which time he ran a persistent septic temperature. *Streptococcus viridans* was cultured from the blood. There was no response to antibiotics. Splenomegaly developed, as did ascites. Approximately fourteen weeks after admission a liver biopsy revealed metastatic carcinoma. Following this the patient became jaundiced, his condition rapidly declined, and he died in coma. During his hospitalization twenty-six diagnoses were considered as plausible.

Postmortem examination disclosed primary alveolar-cell carcinoma with metastases to the lungs, myocardium, liver, kidneys, and suprarenal glands. Microscopic examination showed the subpleural lymphatics to be filled and distended by tumor cells.

Retrospective study of the chest roentgenogram made four months prior to the liver biopsy indicates dilatation of the subpleural lymphatics (Fig. 5). Had this been recognized it could well have been an early clue to the correct diagnosis.

**CASE III:** H. B., a 74-year-old white male, was admitted to the hospital because of dyspnea, orthopnea, anorexia, weight loss, oliguria, and ankle edema of from one to four weeks duration. In 1945 he purportedly had a carcinoma of the larynx removed. In 1953, three years prior to the present admission, a transurethral prostatectomy had been performed for carcinoma and the patient had since been on estrogen therapy. On admission, he was emaciated and dyspneic but not cyanotic. The neck veins were distended; the chest was emphysematous, and numerous rhonchi and râles were heard throughout both lung fields. The liver was palpable. There was pitting pedal and sacral edema. The breasts were enlarged. Temperature was  $100^{\circ}\text{F}$ .

A frontal chest roentgenogram (Fig. 6) showed left pleural effusion, dense left upper lobe consolidation, a heavily calcified 3-cm. mass in the right mid-lung field, gynecomastia, and prominent dilated subpleural lymphatics in the base of the right hemithorax. Because of the past history and by exclusion of other causes of pleural lymphectasia a diagnosis of carcinomatous metastases in the lung and pleura was made. The patient died four weeks after admission, having shown no response to nitrogen mustard therapy.

Autopsy revealed anaplastic bronchogenic carcinoma arising from a left lower lobe bronchus with metastases to the pleura, pericardium, myocardium, mediastinal, internal mammary and pulmonary

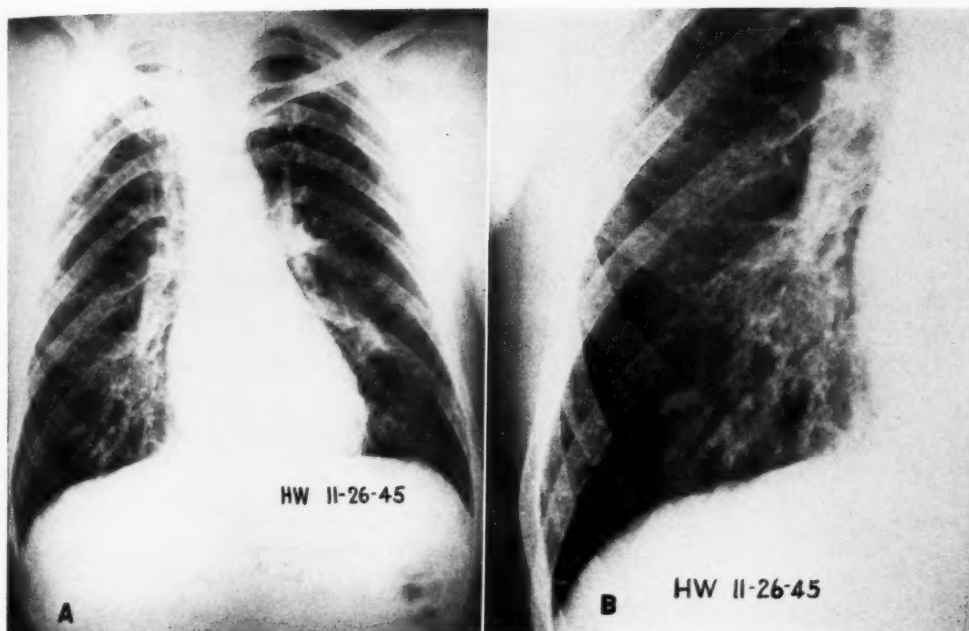


Fig. 5. Case II. A. Chest roentgenogram with bilateral patchy consolidation. Dilated basal interlobular septa are present bilaterally, more marked on the right.  
B. Magnification of right lower lung field.

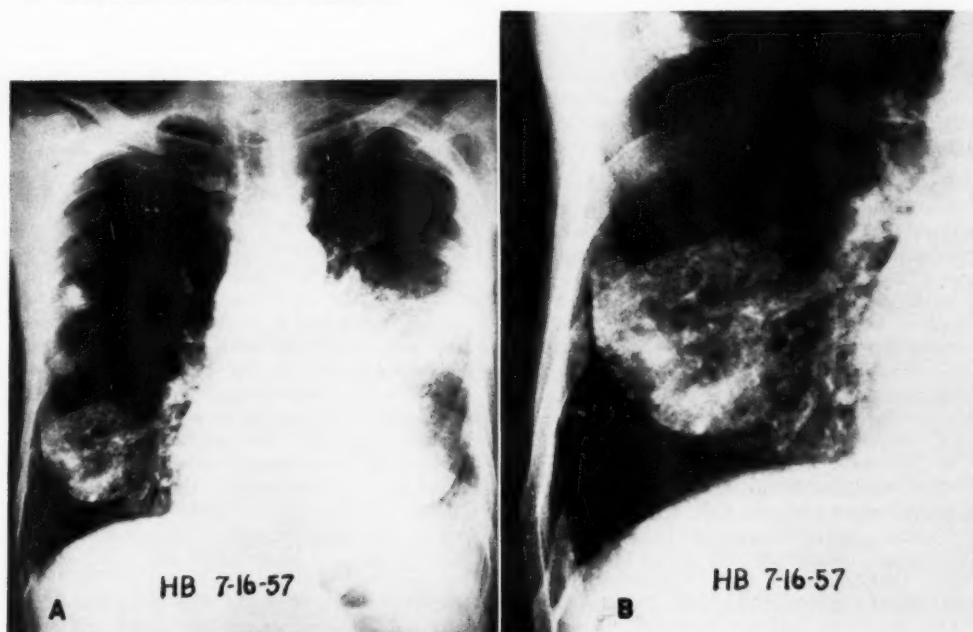


Fig. 6. Case III. A. Bilateral basal horizontal lines are present. Those on the left are partially obscured by pleural effusion. The gynecomastia is secondary to estrogen therapy. The calcified mass on the right proved to be a granuloma.  
B. Magnification of right lower lung field.



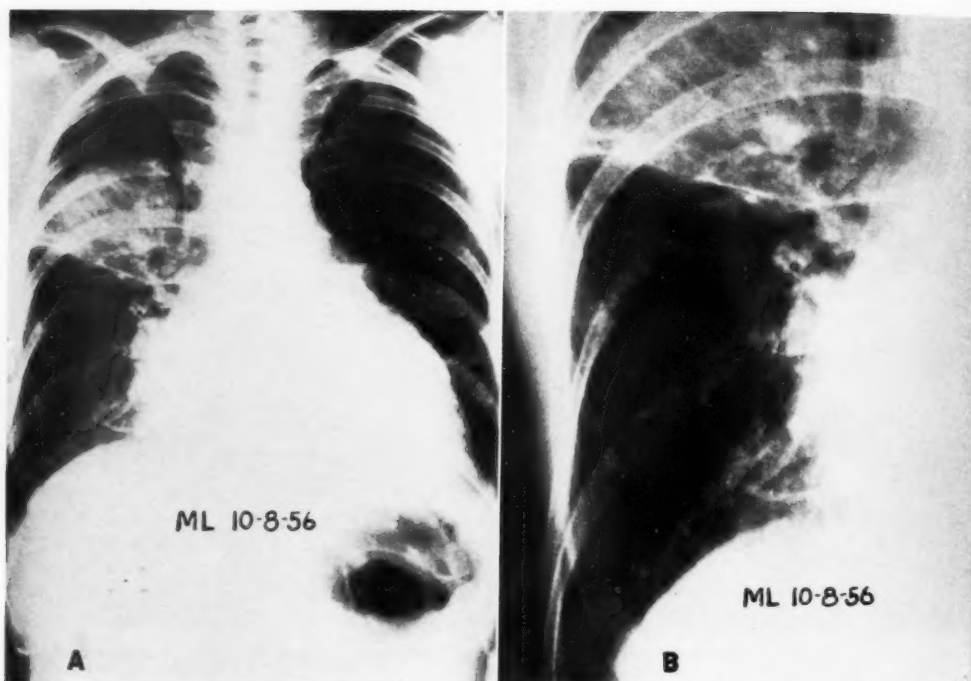


Fig. 7. Case IV. A. Dilated interlobular septa are present at the periphery of the right midlung field, subjacent to the upper lobe mass.  
B. Magnification of right lung field.

lymph nodes, liver, and prostate. Tumor cells were found in subpleural lymphatics bilaterally. The calcified lesion in the right lung was a fibrocaseous granuloma.

**CASE IV:** M. L., a 47-year-old white housewife, had a persistent respiratory infection with cough for approximately four months prior to hospital admission. There had been no hemoptysis. The cough became severe about two weeks prior to admission, during which interval the patient became dyspneic and orthopneic. Weight loss had been considerable. A chest film made prior to hospitalization revealed a 7-cm. mass in the right upper lobe. This mass had not been present two years earlier when a thyroidectomy for exophthalmic goiter had been performed at Michael Reese Hospital. The admission film is reproduced in Figure 7. This revealed, in addition to the mass, dilatation of the subpleural lymphatics in the same area but not in the bases. The lesion was considered most likely a bronchogenic carcinoma with spread at least to adjacent lymphatics. A right supraclavicular mass was felt and removed. This proved to be metastatic carcinoma. The patient's condition deteriorated rapidly and she died eleven days after admission to the hospital.

Postmortem examination showed the superior part of the anterior mediastinum to be infiltrated with

hard, gray-white tumor tissue which surrounded the superior vena cava at its junction with the right atrium. Tumor tissue also encircled the main branches of the arch of the aorta and extended up into the right side of the neck. There was a 6-cm. mass around the right upper lobe bronchus. This bronchus was the primary site of an anaplastic carcinoma. The pathologist reported that "some of the tumor cells extend up to the lymphatics beneath the pleura."

**CASE V:** J. K., a 51-year-old white male, was admitted to a tuberculosis hospital on April 16, 1958, because of a localized lesion in the left upper lobe. He had had an upper respiratory infection in December 1957 and since then had suffered progressive weight loss, shortness of breath, productive cough, and intermittent upper left chest pain. There had been no hemoptysis. The patient had smoked about one and a half packages of cigarettes per day for eighteen years. He was a moderately heavy drinker. The second strength PPD skin test was positive, but sputa were repeatedly negative for acid-fast bacilli and fungi. The upper lobe density increased in size, became excavated, and spread toward the hilus.

On May 5, 1958, the patient was transferred to Michael Reese Hospital. The initial chest roentgenogram (Fig. 8) revealed a left upper lobe mass

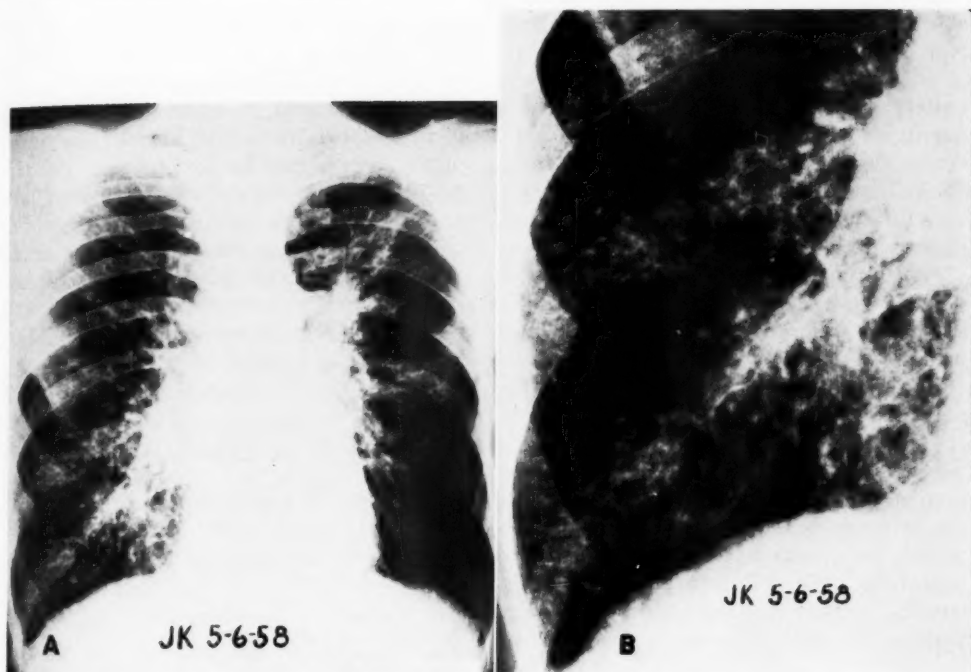


Fig. 8. Case V. A. Left upper lobe mass with extension to the hilum. The right lower lung field has a coarse honeycomb pattern. Prominent horizontal lines are present in the right base. B. Magnification of right lung field.

and enlargement of the left hilum. The entire right lower lung field had a honeycomb appearance. Kerley lines were prominent in the right base. The radiologic diagnosis was lymphogenous dissemination of metastases to lungs and pleura, probably from a bronchogenic carcinoma. Two bronchoscopic examinations with one bronchial biopsy failed to yield a positive diagnosis. Fourteen sputum specimens were studied; two specimens (on May 21 and May 29) were reported positive for carcinoma cells. On May 27, a left lower lobe biopsy was performed *via* thoracotomy. The report was: "Carcinoma infiltration of peribronchial and subpleural lymphatics with focal invasion of subpleural fibrous tissue." The patient was discharged from the hospital on June 7, 1958. At the time of this report the downhill course has been progressive.

#### DISCUSSION

It is apparent that dilated subpleural lymphatics are seen in relatively few conditions. Grainger and Hearn divide these very simply into conditions with impaired centripetal flow of lymph, where there is stasis within and dilatation of the interlobular lymphatics, and those with distention of lymphatics due to increased

transudation of fluid from the pulmonary capillaries into the pulmonary stroma, with subsequent edema of the interlobular septa. It is not known certainly why the dilated septal lymphatics and interlobular septa should be confined for the most part to the lower portions of the lung. This is probably related to the increased hydrostatic pressure in these areas. Most of the diseases causing the septal dilatation can be readily recognized by history, physical examination, routine laboratory studies, and roentgen signs. Thus, in the cases presented in this report pulmonary venous hypertension, pneumoconiosis, sarcoidosis, and leukemia could be quickly excluded and Hodgkin's disease almost so. With this rapid exclusion process, the sole diagnostic possibility remaining is lymphangitis carcinomatosa. Incidentally, review of our own cases of sarcoidosis, pulmonary and mediastinal Hodgkin's disease, and leukemia failed to disclose a single instance where recogniz-

able lymphatic dilatation was present. Nor have Kerley's lines been seen in any case of tuberculosis, including the miliary variety. Admittedly, in some very infrequent instances the basal lines appear in acute pneumonia and probably in other clinical and roentgenologic entities. In such conditions this finding is quite transient and rapidly disappears. It is probably due to some increased transudation of fluid from the pulmonary capillaries in response to an inflammation or to transient increase in capillary permeability.

The importance of recognizing subpleural lymphatic dilatation is self-evident. It may well indicate the diagnosis and suggest the prognosis. When the phenomenon is due to disseminated carcinoma the latter is generally in the later stages, with a few weeks to a few months life expectancy. The illustrative cases were chosen because the roentgenograms lent themselves well to reproduction. They represent a small sampling of many instances in which dilated lymphatics were identified in patients subsequently proved to have metastatic carcinoma in the lung.

#### SUMMARY

One of the causes of subpleural pul-

monary lymphatic dilatation is obstruction and distention of these vessels by tumor cells. The dilated lymphatics may become visible on chest roentgenograms in the form of short transverse lines in the bases of the lungs, permitting one to make the diagnosis of metastatic carcinoma. There are relatively few other conditions which will cause the subpleural lymphatics to distend, and these can usually be readily excluded. Illustrative case histories and roentgenograms are presented.

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#### SUMMARIO IN INTERLINGUA

##### **Lymphectasia Interlobular Subpleural Reflectente Carcinoma Metastatic**

Un del causas de dilatation del lymphaticos pulmonari subpleural es le obstruction e le distension de iste vasos per cellulas tumoric. Le lymphaticos dilatate pote devenir visibile in roentgenogrammas thoracic in le forma de curte lineas transverse in le bases del pulmones, rendente

possibile le diagnose de carcinoma metastatic. Relativamente pauc altere conditiones causa distension del lymphaticos subpleural, e in general iste conditiones pote facilmente esser excludite.

Es presentate illustrative historias de casos.

## The Radiographic Evaluation of Pulmonary Vasculature in Children with Congenital Cardiovascular Disease<sup>1</sup>

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THE AVAILABILITY of surgical procedures for the treatment of congenital malformations of the heart in children has made necessary an increasing accuracy in their diagnosis. Many malformations require, for accurate identification, an analysis of data obtained clinically, by conventional chest radiography, and by cardiac catheterization and/or cardioangiography. Since the conventional chest film is usually the most common study in conjunction with clinical examination, it is important to use it as fully and accurately as the method allows. The status of the pulmonary vasculature is one criterion in reaching a radiologic diagnosis by the relatively simple technic of teleroentgenography.

A radiologic diagnosis of increased or decreased pulmonary vascularity may require actual measurements of the vessels on the chest film, but is usually obtained from a general impression of the shadows of the pulmonary fields. Measurements have been undertaken in adults (5), but in children with congenital heart disease, this procedure is complicated by the poor definition of the vessels (sometimes associated with active vascular engorgement or congestive failure) and the difficulty of evaluating an absolute measurement in relation to any variable reference standard such as height, weight, chest size, or other somatic measurement in the growing individual.

The present study was undertaken in an effort to evaluate the ability to appreciate increased or decreased pulmonary vascularity in conventional radiographs of the chest in children with congenital cardio-

vascular malformations of a known nature. It was hoped thereby to determine the degree of security with which deviations from the normal could be recognized in undiagnosed malformations.

### MATERIALS AND METHODS

Films of patients with known and proved congenital cardiovascular disease were obtained from the files of the Department of Radiology of Children's Hospital (Cincinnati, Ohio). Only cases which would be expected to have altered pulmonary vascular patterns, such as left-to-right shunts, pulmonic stenosis, or similar malformations, were included. All patients had been studied by angiocardiology, cardiac catheterization, surgery, autopsy, or a combination of two or more technics, so that their pulmonary vascular status could be classified with reasonable security.

The selection of films was made by a group of three physicians from the Departments of Cardiology and Radiology, experienced in the diagnosis of congenital cardiovascular disease. Only films which were unanimously considered to show definite over- or under-vascularity, and with which the cardiopulmonary studies were in accord, were accepted for study. Instances of "normal" vascularity were eliminated, notwithstanding abnormal cardiopulmonary studies. Films obtained after operation or from cases with coincidental lung disease were also excluded.

A single chest film in the frontal projection was selected for each of 64 patients, 32 with over- and 32 with under-vascular-

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TABLE 1: FREQUENCY AND NATURE OF CARDIAC ABNORMALITIES\*

Diagnosis	Vascularity		
	Normal	Over-vascularity	Under-vascularity
Normal	64	..	..
Patent ductus arteriosus	..	18	..
Transposition	..	8	..
Interventricular septal defect	..	6	..
Fallot's tetrad	..	..	14
Tricuspid atresia	..	..	11
Pulmonic stenosis	..	..	7
Totals	64	32	32

\* The age distribution is omitted because of the small number in each diagnostic category. However, we can state that 16 patients were under 6 months, 20 were between 6 months and 3 years, and 15 were between 3 and 7 years. The remainder were between 7 and 14 years. The normal controls had an identical distribution. Severely cyanotic patients, *e.g.*, those with transposition or tricuspid atresia were found almost exclusively in the 2 youngest groups.

ity. The diagnoses are listed in Table I. All selected films were obtained with reasonably good technic for erect tele-roentgenograms in the inspiratory phase of respiration. However, the selection was not confined to *excellent* films, since it was desired to approximate more nearly the films seen in daily radiologic practice. Each film was matched with a normal control by age, sex, and degree of "reasonably good technic." The resultant 128 films were given random test numbers according to the tables of Arkin and Colton (1). They were then treated as described below and presented to "readers" in groups of 32 films each, in sequence determined by the test numbers.

The experiment was designed to avoid bias due to clinical information and to psychologic slant of the individual reader. In order to eliminate clues provided by the heart size and shape, the chest was covered except for the major portion of the right lung, as illustrated in Figure 1. A line was drawn horizontally across the right hemithorax just above the right leaf of the diaphragm from the inner border of the ribs to the right border of the vertebral column. A straight line was then drawn from the midpoint of this line to the lateral border

of the right transverse process of the second dorsal vertebra. All of the thorax to the left of the latter line was covered by black paper, and only the portion of the right lung lateral to this line was used for the interpretation of pulmonary vascularity. The black paper effectively obscured the heart and the major portion of the right hilus.

The readers were radiologists with different types of experience—university hospital, private hospital, and private practice. All three, however, had been associated in residency training. The films were presented to each physician individually, without association with the other readers. The reader did not know the name of the patient nor had he any other clue which would allow him to identify the person whose film he was reading. He was asked whether the film demonstrated normal, increased, or decreased pulmonary vascularity, and his opinion was recorded immediately at the time of reading.

Each film was seen by each reader three times. At the initial reading, the chest was covered except for the major part of the right lung, as described above. After an interval of several weeks, the reader was presented with the same masked films, without being informed of this repetition. So far as the individual reader was concerned, the second reading merely constituted an extension of the original problem, and was not recognized as a repeated reading of films previously examined. This second reading was designed to test intra-personal correlation. At a final reading, the entire group of films was reviewed with the black paper and masking tape removed. The reader had no information concerning his previous judgment of any given film. This procedure was designed to test the influence of heart size and shape on evaluation of pulmonary vasculature.

In order to eliminate personal bias, that is, the tendency to over-read or to under-read, a restriction was imposed on all readers. At the beginning of the study, when viewing the first group of films, each reader was told that each group of 32



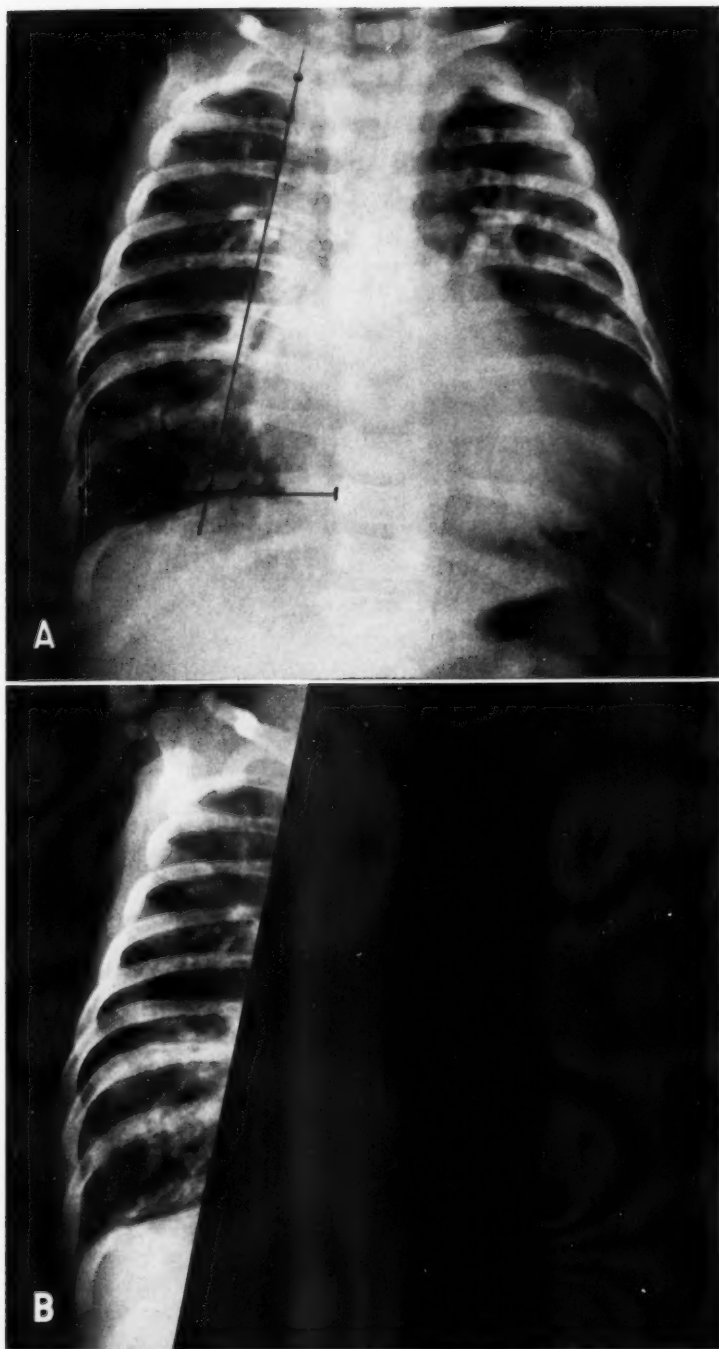


Fig. 1. A. Landmarks for horizontal and diagonal lines used in masking the chest films.

B. Masking of left lung, heart, and right hilus is completed and film is ready for "reading."

TABLE II: ERRORS BY READER AND TYPE OF ERROR

	Readers			Total
	A	B	C	
<i>First Reading</i>				
Normal scored decreased	16	17	15	48
Decreased scored normal	13	16	15	44
Normal scored increased	2	2	1	5
Increased scored normal	5	3	1	9
Decreased scored increased	3	1	0	4
TOTAL	39	39	32	110
<i>Second Reading</i>				
Normal scored decreased	14	16	15	45
Decreased scored normal	12	16	14	42
Normal scored increased	1	1	2	4
Increased scored normal	3	1	3	7
Decreased scored increased	2	0	1	3
TOTAL	32	34	35	101
<i>Third Reading</i>				
Normal scored decreased	12	1	10	23
Decreased scored normal	15	17	9	41
Normal scored increased	1	3	1	5
Increased scored normal	4	2	2	8
Decreased scored increased	0	2	0	2
TOTAL	32	25	22	79
<i>All Three Readings</i>				
Normal scored decreased	42	34	40	116
Decreased scored normal	40	49	38	127
Normal scored increased	4	6	4	14
Increased scored normal	12	6	6	24
Decreased scored increased	5	3	1	9
TOTAL	103	98	89	290

films was composed of 16 normal films, 8 films with pulmonary over-vascularity, and 8 films with pulmonary under-vascularity. At the first two readings, therefore, when the black paper obscured the major portion of the chest, the reader was compelled to score 16 films as normal, 8 as over-vascularized, and 8 as under-vascularized, even if this necessitated some changes in his original impression. At the third and final reading, the proportion of films was maintained but the reader was free to score them without regard to the total number in each category.

#### RESULTS

There were altogether 128 films (4 groups of 32 films each), which were seen by each reader three times—hence there were 384 responses per reader. The responses of the readers according to the type of error and according to the diagnoses are listed in Tables II and III.

*Number of Errors per Reader:* At the first

reading of 128 films, an average of 37 errors per reader (range 32–39) was noted; at the second reading, the average was 34 errors per reader (range 32–35), and at the third reading (uncovered) 26 errors per reader (range 22–32). For all readings, the average was 97 errors per reader, with a range of 89 to 103. The incidence of error for all readings and all readers, therefore, averaged approximately 25 per cent.

*Type of Error:* The great majority of errors was made in differentiating between normal and decreased vasculature. At the first reading, normal vasculature scored decreased and decreased vasculature scored normal comprised 92 out of 110 errors, or 84 per cent. At the second reading, 87 of the 101 errors (86 per cent) occurred in this same group, and at the third reading, 64 of the 79 errors (81 per cent). The difficulty in distinguishing between normal and decreased vasculature accounted for 243 out of the total of 290 errors for all three readings, or 84 per cent of all errors.

In contradistinction, the differentiation between normal and increased vasculature was good. At the first reading, errors in this area accounted for only 14 of the 110 errors (13 per cent); at the second reading 11 of the 101 errors (15 per cent), and at the third reading 13 of the 79 errors (15 per cent). Failure to differentiate between normal and increased vasculature thus accounted for only 38 of the 290 errors, or 13 per cent.

An infrequent but interesting error consisted in the scoring of decreased vascularity as increased. This accounted for only 4 of the 110 errors in the first reading, 3 of the 101 errors in the second reading, 2 of the 79 errors in the third reading, making 9 of the total of 290 errors, or 3 per cent. It is of particular interest that this error occurred only in cases of the tetralogy of Fallot. In each case, numerous fine tortuous vessels of bronchial circulation were scored as increased vasculature, while in reality the caliber of these vessels was quite small and the total pulmonary vascularity was decreased. The converse—scoring of

TABLE III: ERRORS BY READER AND DIAGNOSIS

Diagnosis	No. of Cases	No. of Readings	Readers			Total Errors	% Errors
			A	B	C		
<i>First Reading</i>							
Patent ductus	18	54	4	2	0	6	11
Transposition	8	24	0	0	0	0	0
Interventricular septal defect	6	18	1	1	1	3	17
Tetralogy	14	42	8	6	6	20	48
Tricuspid atresia	11	33	4	5	3	12	36
Pulmonary stenosis	7	21	4	6	6	16	76
Normal	64	192	18	19	16	53	28
TOTAL	128	384	39	39	32	110	29
<i>Second Reading</i>							
Patent ductus	18	54	2	0	2	4	7
Transposition	8	24	0	0	0	0	0
Interventricular septal defect	6	18	1	1	1	3	17
Tetralogy	14	42	6	7	7	20	48
Tricuspid atresia	11	33	3	3	4	10	30
Pulmonary stenosis	7	21	5	6	4	15	70
Normal	64	192	15	17	17	49	25
TOTAL	128	384	32	34	35	101	26
<i>Third Reading</i>							
Patent ductus	18	54	3	1	1	5	9
Transposition	8	24	0	0	0	0	0
Interventricular septal defect	6	18	1	1	1	3	17
Tetralogy	14	42	6	8	5	19	45
Tricuspid atresia	11	33	3	5	3	11	33
Pulmonary stenosis	7	21	6	6	1	13	62
Normal	64	192	13	4	11	28	15
TOTAL	128	384	32	25	22	79	21
<i>All Three Readings</i>							
Patent ductus	18	162	9	3	3	15	9
Transposition	8	72	0	0	0	0	0
Interventricular septal defect	6	54	3	3	3	9	14
Tetralogy	14	126	20	21	18	59	47
Tricuspid atresia	11	99	10	13	10	33	33
Pulmonary stenosis	7	63	15	18	11	44	70
Normal	64	576	46	40	44	130	22
TOTAL	128	1152	103	98	89	290	25

increased vasculature as decreased—did not occur in this study.

*Frequency of Errors by Diagnosis:* In the group with pulmonary over-vascularity, there were films from 18 patients with patent ductus arteriosus, each of which was seen three times by each of the three examiners. There were 15 errors in the 162 readings, or 9 per cent, with no significant difference in each of the three readings. The 15 errors were made on the films of 7 patients; the films of the remaining 11 patients were always scored correctly.

Eight films were from cases of transposition of the great vessels and no errors were made in 72 readings of these films. In all patients there was marked pulmonary over-vascularity.

Six patients in the series had interventricular septal defect and a total of 9 errors was made in 54 readings in this group (17 per cent). There was no significant difference between the three readings. It is of interest that all the errors by all three readers were made on the same film and at all three readings (covered and uncovered). This film was from a patient with only mild pulmonary over-vascularity. The films on the remaining 5 patients were scored correctly by all three readers in all three readings, a remarkable intra- and interpersonal consistency.

The total number of errors in the group of patients with pulmonary over-vascularity was 24 out of 288, or 8 per cent. The accuracy of this group of cases is thus high,

TABLE IV: ARC SINE TRANSFORMATION OF NUMBER OF ERRORS OF DIAGNOSIS

Errors in Case of →	Decreased Vascularity			Increased Vascularity		
Reader →	A	B	C	A	B	C
<i>First Reading</i>						
Proportion scored incorrectly	16/32	17/32	15/32	5/32	3/32	1/32
Per cent	50.0%	53.1%	46.9%	15.6%	9.4%	3.1%
Angle $\gamma$ (degrees)	45.00	46.78	43.22	23.26	17.85	10.14
<i>Second Reading</i>						
Proportion scored incorrectly	14/32	16/32	15/32	3/32	1/32	3/32
Per cent	43.8%	50.0%	46.9%	9.4%	3.1%	9.4%
Angle $\gamma$ (degrees)	41.44	45.00	43.22	17.85	10.14	17.85
<i>Third Reading</i>						
Proportion scored incorrectly	15/32	19/32	9/32	4/32	2/32	2/32
Per cent	45.9%	59.4%	28.1%	12.5%	6.2%	6.2%
Angle $\gamma$ (degrees)	43.22	50.42	32.01	20.70	14.42	14.42

with no appreciable difference between the three readings (covered and uncovered).

In the group of patients with pulmonary under-vascularity, there were 14 patients with tetralogy of Fallot. Here the total number of errors was 59 out of 126 readings or 47 per cent. There was no appreciable difference in the number of errors made by the three readers or in the three readings of each reader. The 59 errors were made on 11 out of the 14 cases. Three patients with the tetralogy of Fallot were scored as under-vascularized in each of the three readings by the three readers.

There were 11 patients with tricuspid atresia and 33 errors in 99 readings or 33 per cent was noted in this group. The errors were made on 6 of the 11 films. Conversely, 5 of the patients were consistently and correctly designated as under-vascularized in each of three readings by each of the three readers, demonstrating a considerable degree of consistency in this particular malformation.

In the patients with pulmonic stenosis, of which there were 7, there occurred 44 errors out of 63 readings (70 per cent), the highest degree of inaccuracy in the group studied. Each of the 7 films was incorrectly scored at one or another reading.

In summary, the total number of errors in the group of patients with pulmonary under-vascularity was 136 out of 288 readings, or 47 per cent. The diagnostic accuracy, therefore, was poor in comparison with pulmonary over-vascularity.

Of considerable interest is the fact that for the 64 normal films there were 130 errors in 576 readings (22 per cent).

#### STATISTICAL ANALYSIS

The experiment was designed to permit statistical comparison of the errors in interpretation of films in cases with known increase or decrease of vascularity and the interaction of this contrast with the readers and with the trials. Interdependence between the readers' responses was minimized by the device of matching each test film with a normal film and then disregarding the misclassifications of the normal "controls." Thus, the normals act as a "buffer," so that responses on over- and under-vascularity are essentially independent. The number of errors of diagnosis was counted therefore for cases of decreased and increased vascularity, by reader and by trial. Each of these counts was expressed as a percentage of the maximum number of errors for each category, which is seen to be 32.

The design described above permits the use of a statistical technic known as the "analysis of variance," a tool especially useful for its extreme flexibility and for its robustness in withstanding mild departures in the validating assumptions underlying the analysis. Nevertheless, in order not to strain this robustness too much, the data can be transformed by a suitable algebraic manipulation so that certain assumptions are better met. One such as-

sumption is that of constant mean-square-error. It is well known that when the original data are binomially distributed, the mean-square-errors are not expected to be constant. However, a transformed quantity, "y," found by taking the angle whose sine is equal to the square root of the observed proportion does have constant expected mean-square-error to a first approximation. The data with respect to proportions of errors presented in Table IV are approximately binomially distributed and hence the transformation alluded to (termed the *arc sine transformation*) is appropriate. The angles (in degrees) corresponding to the observed proportion are given in Table IV. It is these angles, instead of the observed proportions, that are statistically evaluated.

Since the "analysis of variance" technic has been described adequately in most elementary textbooks of statistics, there is no need for repetition here. Reference can be made to Snedecor (12), Chapters 10 and 11. Sections 11:10 and 11:12 explain the need for and use of transformations. In essence, the analysis of variance is an arithmetical device for partitioning the sum of squared deviations from chance expectation into portions each of which can be identified with some source, such as variation between readers, or between trials, etc. It is a useful and common practice to separate out part of the sum of squares due to various *interactions*. The meaning of interaction can best be made clear by an illustration. Suppose the readers differ among themselves as regards their proportion of misclassifications, and further suppose that the average proportion of misclassifications is different for the two categories, over- and under-vascularity. There is then said to be a *reader × category interaction* if the over-vascularity-under-vascularity difference is inconsistent from reader to reader.

So long as certain assumptions about the data are met (e.g., constant mean-square-error), tests of various hypotheses concerning the population of results, of which our data are regarded as a sample,

TABLE V: ANALYSIS OF VARIANCE OF ANGLES FROM TABLE IV

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	Chi-Square
Readers (R)	2	86.0052	43.00	3.35
Trial (T)	2	13.2212	6.61	0.52
Vascularity (V)	1	3298.8857	3298.89	128.61
R × T interaction	4	91.2332	22.81	3.56
R × V interaction	2	91.7390	45.87	3.58
T × V interaction	2	6.5455	3.27	0.26
R × T × V interaction	4	68.7108	17.18	2.68
TOTAL	17	3656.3406	...	...
Theoretical	∞	...	25.65	...

can be made. For example, for purposes of testing, we may postulate that there are no real differences between the readers in their misclassification tendencies, and that the small observed discrepancies are the result of sampling. If the test is significant at the 5 per cent level, then we conclude that the postulate is untenable and that we have 95 per cent confidence in our conclusion. This uncertainty as to the validity of a conclusion is the inevitable result of making an inductive inference. The quantification of the uncertainty is a fruit of the statistical method.

An analysis of the variance (ANOVA) of the angles "y" was performed and the results are summarized in Table V. A theoretical variance is provided by the transformation, and this theoretical variance takes the place of the usual empirical error mean square in the tests of significance. The test statistic

$$\frac{S. S. (treatment)}{\text{theoretical variance}}$$

is distributed approximately as chi-square under the null hypothesis and hence chi-square tests replace the more usual F tests in the analysis of variance table. That the theoretical variance is appropriate in this case is empirically confirmed by testing the *Reader × Trial × Vascularity* interaction mean square against the theoretical variance.

The conclusions which can be drawn



from the statistical analysis of the data are as follows:

1. There is no significant difference between readers or trials.
2. The rate of errors in case of decreased vascularity is estimated to be  $5\frac{2}{3}$  times the rate of errors in the case of increased vascularity. This is highly "significant" in a statistical sense.
3. The rate of errors was consistent for different combinations of readers and trials.
4. The difference in error rate depending upon vascularity was not significantly affected by reader or trial.

#### DISCUSSION

The works of Garland (2, 3, 4) and Yerushalmy *et al.*, (6-11) have done much to make radiologists aware of the scope and limitations of diagnosing pulmonary disease from chest films with respect to intra-personal and interpersonal errors. The influence of clinical data and of psychologic slant on reaching a radiologic interpretation was effectively demonstrated. The experiment described above attempted to eliminate the factors of psychologic slant and clinical bias by forcing a known bias on each of the readers. In so doing, it was hoped to evaluate the reliability which can be placed on radiologic interpretation of pulmonary over- or under-vascularity, with respect to the diagnosis of congenital cardiac malformations.

That the "built-in bias" was operative is nicely shown by an unintended experiment on the part of Reader B. At the time of the third reading, when the masking paper had been removed, readers A and C elected to maintain a 1-2-1 ratio in interpretations of under-vascularity, normal, and over-vascularity respectively, as in the previous readings. Reader B, however, believed that he could not recognize under-vascularity and classified all questionable under-vascularity films as normal (Tables II and III). The result of this decision is shown in the marked decrease in the number of errors he made in the classification of normal "controls." His "improvement" is striking in comparison with his previous scores in this category, and in comparison

with the other two readers as well. Since the misclassifications of normals are disregarded in the statistical calculations, this irregularity did not appreciably affect the analysis.

Perhaps a questionable point in this study is the empirical choice of what was to represent over- and under-vascularity; however, with the availability of information concerning the actual anatomy—degree of stenosis, magnitude of shunts, etc.—and with insistence on a unanimous agreement for classification consistent with this information, we believe that our "standards" would be acceptable to most physicians under the same conditions.

The statistical analysis indicates a high degree of internal consistency; in other words, there is no more than chance variation between different readers or between different readings on the part of any one of the three readers in evaluation of the test series of films. This consistency would suggest that standards for pulmonary over- and under-vascularity as developed in the course of training and experience in radiology are comparable in different levels of radiologic practice and that our test standards were satisfactorily chosen. The analysis does indicate that these standards were appreciably more reliable in this study with respect to the diagnosis of pulmonary over-vascularity than with respect to the diagnosis of pulmonary under-vascularity.

Additional support for this statement is provided in the observation that all the errors were made in only 7 of the 18 patients with patency of the ductus arteriosus, in only 1 of the 6 with an interventricular septal defect, and that no errors were made in the 8 patients with transposition; whereas in the case of the tetralogy of Fallot the errors were distributed among 11 of the 14 patients, films of 5 of 11 patients with tricuspid atresia and films of all 7 patients with pulmonic stenosis were incorrectly scored at one time or another.

#### SUMMARY

In a planned statistical study, a test was made of the ability of radiologists to recog-

nize pulmonary under- and over-vascularity by presenting the readers with films of 32 patients who were agreed by another group of readers to demonstrate pulmonary over-vascularity, and films of 32 patients who were agreed to demonstrate pulmonary under-vascularity. The radiologic assessment of the initial readers was supported by special studies including cardiac catheterization, angiocardiology, operation, and in some instances necropsy. The 64 films thus available for analysis were matched by age, sex, and radiologic technic with normal chest films from the files of the Children's Hospital (Cincinnati, Ohio) Department of Roentgenology. The resultant 128 chest films were randomized and presented three times to each of three "readers."

The first two readings were obtained with the chest obscured except for the lateral two-thirds of the right hemithorax. The third reading was made with the entire chest exposed as in a routine reading. Statistical analysis was made of the errors in classification in the two test groups of 32 films each. There was no appreciable difference between readers or readings but there was a distinct difference in the number of errors related to the recognition of pulmonary under-vascularity in comparison with the recognition of pulmonary over-vascularity. It is apparently much easier to recognize pulmonary over-vascularity than it is pulmonary under-vascularity in children with congenital malformations of the heart.

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#### SUMMARIO IN INTERLINGUA

#### Le Evaluation Radiographic Del Vascularura Pulmonar In Patientes Pediatric Con Congenite Morbo Cardiovascular

In un planate studio statistic, un test esseva executate concernente le capacitate de radiologos de recognoscer hypovascularitate e hypervascularitate, per presentar a un gruppo de lectores un serie de 32 films que monstrava—secundo un altere gruppo de lectores—hypervascularitate, e 32 que

monstrava—secundo le mesme secunde gruppo—hypovascularitate. Le evaluation radiologic del lectores initial esseva supportate per le resultados de studios special que includeva catheterisation cardiac, angiocardiology, operationes, e in certe casos necropsia. Le 64 films assi dis-

ponibile pro le analyse esseva appaerate secundo etate, sexo, e technica radiologic con normal films del pectore ab le archivos del Hospital Infantil de Cincinnati, Ohio. Le resultante 128 films thoracic esseva randomisate e presentate tres vices a tres lectores individual.

Le prime duo lecturas esseva effectuate con le thorace obscurate con le exception del duo tertios lateral del hemithorace dextere. Le tertie lectura esseva facite con le integre thorace exponite como in un lectura rutinari. Esseva facite un analyse

statistic del errores in classification in duo gruppos experimental de 32 films cata un. Nulle differentias appreciable esseva constatate inter le lectores o le lecturas, sed il habeva un distincte differentia in le numero de errores relationate con le recognition de hypovascularitate pulmonar in comparation con le recognition de hypervascularitate pulmonar. Apparentemente il es multo plus facile recognoscer hypervascularitate que hypovascularitate pulmonar in pacientes pediatric con congenite malformationes cardiac.



## Pleural Effusions Following Supervoltage Radiation for Breast Carcinoma<sup>1</sup>

ARNOLD L. BACHMAN, M.D., and KEVIN MACKEN, M.D.

THE APPEARANCE of a pleural effusion in a patient previously treated for carcinoma of the breast has been almost universally considered to indicate metastatic involvement of the pleura and a serious prognosis, particularly if the neoplasm was originally considered inoperable or showed evidence of recurrence following surgery. In the past, this interpretation was almost invariably correct, whether or not the treatment included radiotherapy to the breast and its adnexal regions. Exceedingly few nonmalignant effusions were noted during the era when 200- to 250-kv therapy was conventionally employed, and the pleura has been considered distinctly radioresistant. In recent years, however, ultrahigh-voltage therapy has permitted considerably larger doses to be delivered to the mediastinal, pleural, and parenchymal regions, as well as to the loci of probable disease. As a result, greater radiation effects on the pleura, lung parenchyma, and mediastinal region have been anticipated and, indeed, already noted in a number of clinics where these higher voltages have been employed.

At the Francis Delafield Hospital, 2-million-volt radiotherapy has been directed to the breast, axilla, and supraclavicular and internal mammary regions in the treatment of inoperable breast carcinoma and of certain cases postoperatively. With the employment of this technic, we have observed the development of pleural effusions in a small but significant number of cases in which the course and clinical observations strongly suggested that the fluid did not represent metastases but may well have been the result of irradiation. These patients have remained well for considerable periods of time with their

effusions and have shown no other signs of possible metastases. Because supervoltage therapy is assuming an increasing role in the treatment of breast carcinoma, it was thought desirable to report this group of cases.

The effects on the lung fields of radiotherapy of regional neoplastic disease have been extensively dealt with in numerous communications since the report by Groover, Christie, and Merritt (1), in 1923, on a series of such cases. Most authors make little or no mention of pleural changes, stressing almost exclusively alterations in the pulmonary parenchyma. Indeed, Engelstad (2, 3), after his thorough investigation of the effects of radiations on the lungs of animals, concludes that the pleura is radioresistant and that pleural changes are seldom encountered in spite of marked parenchymal damage. These findings are in accord with those of Warren and Gates (4, 5), who postulate that the pleura, being composed mainly of inert fibrous tissue, should be the last structure to react. These authors observed that the changes in several irradiated animals amounted to no more than slight to marked swelling and vacuolization of the mesothelial cells, sometimes accompanied by edema and, rarely, by hyalinization of the underlying connective tissue. Engelstad and Warren and Gates agree that, if pleural effusion occurs following radiotherapy, it represents a complication of the severe parenchymal inflammation, necrosis, and abscesses, and is not due directly to the radiation.

A number of clinical investigators (6-11) have reported the occurrence of pleural effusions shortly after irradiation, in conjunction with radiopneumonitis. While

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each of the reports has included no more than one or two such cases, the effusions appear to have been documented satisfactorily as nonmalignant in character and the total has reached a significant number. Desjardins (7) related the occurrence of pleural reactions to the degree of radiation inflammation. He believed that in the majority of cases the radiopleuritis (but not effusion) was not sufficient to be recognized clinically or roentgenologically during the acute phase. Not infrequently, however, sequelae could be noted in the form of adhesive pleural bands, symphysis of the pleural layers, and obliteration of the costophrenic sinus with restricted diaphragmatic excursion. Bate and Guttman (9) presented 50 cases of pulmonary radiation effects and included 2 instances of pleural effusion in a thorough analysis of their material. Chu *et al.* (11), describing the efficiency of tangential ports in the treatment of breast carcinoma, observed that pleural effusion was a rarity in their series, primarily because the tangential breast ports resulted in greatly diminished depth doses within the thoracic cavity.

The present report is based upon a review of the serial chest roentgenograms of approximately 200 patients with carcinoma of the breast receiving 2-million-volt radiotherapy to the axillary, supraclavicular, and internal mammary regions, with irradiation through tangential ports of the involved breast (in inoperable cases) and the chest wall areas. Eleven cases with noteworthy amounts of fluid in the homolateral pleural cavity were discovered (an incidence of 5 per cent) in which the course and additional clinical investigations strongly indicated that the effusions were not due to metastases. All of these cases were treated in the Department of Radiotherapy at the Francis Delafield Hospital, and the details of portals employed, doses delivered to different areas, time factors, and other information are given in a recent article by Bate and Guttman (9). The pertinent physical data for the 11 cases reported in this communi-

cation are the estimated dosages of 4,000 to 6,000 r delivered to the anterior pleura over the pulmonary apex and the midlung field (the latter by the tangential ports) in a period of four to five weeks. The doses to the posterior pleura of the upper lobes could not be accurately estimated, but were probably considerably less. The medial and lateral anterior tangential fields through the anterior chest wall, immediately deep to the breast, measured 15 by 15 cm. with their superior margins just below the level of the supraclavicular field, at about the level of the second rib anteriorly. They extended downward 15 cm. so that their inferior margins reached to the level of the seventh rib. This plane often included the anteriorly situated dome of the diaphragm and its diaphragmatic pleura.

In reviewing the total material, a large number of cases were observed in which localized pleural adhesions and bands and tenting of the diaphragm were present at various intervals following radiotherapy. In the 11 cases constituting this series, however, there were obviously recognizable pleural effusions unassociated with other possible metastases. The age distribution of the patients and the microscopic character of the breast carcinomas appeared unrelated to the occurrence of the effusion. Some important details with respect to the effusions are presented in Table I. It is apparent that in all 11 cases the fluid was first observed within six months after the conclusion of therapy; in none did it appear later than this. In 6 cases, it was evident within three months after treatment was completed. It may also be noted that in every case with demonstrable effusion there was also radiation pneumonitis. We consider this a significant relationship. In several cases, however, the pneumonitis was found to disappear completely or almost completely while the fluid persisted. A comparison of the time of appearance and extent of effusion with the estimated dose delivered to the pleura in the 11 cases showed no correlation within the rather narrow range of dosage



TABLE I: SUMMARY OF ELEVEN CASES OF RADIATION EFFUSION

Case No.	Time of Appearance of Effusion after End of Radiotherapy (months)	Course of Effusion			Time of Appearance of Radiation Pneumonitis after End of Radiotherapy (months)	Course of Pneumonitis		Character of Effusion; Remarks
		Time of Disappearance (months)	Fluid Still Present at Last Examination			Complete Clearing after Radiotherapy (months)	Fibrosis and Shrinking of Irradiated Area after Radiotherapy	
			After Radiotherapy (months)	Amount of Fluid				
I	4	....	25	Decreased	4	...	7 months Moderate fibrosis	Free basal pleural effusion. No adhesions or loculation. Thoracentesis performed at 25 mos. Fluid negative for malignant cells. Patient well.
II	6	23	...	...	6	...	8 months Mild fibrosis	Free basal pleural effusion. Late pleural adhesions and slight thickening after 3 years.
III	3	....	40	Unchanged	3	9	...	Fluid in general pleural cavity, but also interlobar and intrapulmonary collections. Patient well.
IV	4	...	31	Decreased	2	...	4 months Whole upper lobe markedly shrunken and dense	Free basal pleural effusion with some tenting of diaphragm initially. At 31 months probably thickening of the pleura only.
V	3	9	..	...	3	...	9 months Markedly fibrotic and shrunken upper lobe	Free pleural effusion anteriorly at base. After its disappearance only some tenting of diaphragm remained.
VI	2	....	17	Unchanged	2	...	10 months Mild fibrosis	Free basal effusion plus evident adhesions above diaphragm and tenting of diaphragm.
VII	5	....	30	Slightly increased	5	...	20 months Moderate fibrosis	Free pleural effusion.
VIII	6	Unknown	..	...	6	Unknown	...	Loculated basal effusion. Patient reported alive and well without evidence of disease 3 years later.
IX	2	10	..	...	1	...	4 months Mild fibrosis	Free fluid plus some loculated effusion with adhesions at base laterally. Fluid disappeared with residual pleural thickening at base.
X	3	4	..	...	3	5	...	Small free pleural effusion, completely disappearing. Metastatic effusion appeared 4 years later.
XI	2	...	10	Distinctly decreased	2	...	5 months Marked fibrosis and shrinkage of upper lobe	Free fluid and loculated effusion with adhesions at base slowly increasing in amount early and then decreasing spontaneously by 10 months postradiotherapy.

employed. In some instances where the doses to the axillary, supraclavicular, and tangential fields were slightly higher than in others, the radiation effects appeared later and were somewhat less pronounced. In other cases the opposite was noted.

With a single exception, at least part of the pleural effusion was noted within the free pleural cavity at the base. Only in Case VIII was there a completely loculated effusion. In 8 cases there was evidence of either loculation or adhesions in addition to the free basal accumulation, actual loculations being present in 4 instances. Often the localized fluid collection was observed anteriorly and inferiorly in the interlobar fissure, so that it lay adjacent to the cardiac margin and gave a somewhat bizarre appearance to the general cardiac shadow. However, the effusion opacity could usually be distinguished by a small band of radiolucency incompletely separating it from the true cardiac margin.

In numerous instances, although the findings were not sufficient to be definitely considered as fluid and the cases were therefore excluded from this series, there was observed a tenting of the diaphragm with linear densities extending upward from the diaphragm anteriorly. These bands and diaphragmatic tentings were seen soon after the completion of the course of radiotherapy. They usually diminished slowly but did not completely disappear on the serial films made in the follow-up period.

In the cases with effusion the amount of fluid initially observed varied from small quantities which obliterated the costophrenic sinus and were demonstrable in lateral recumbent views along the dependent margins of the lung field to large collections occupying almost half of the hemithorax. There was no apparent correlation between the radiation dose delivered and the amount of fluid within the range of dosage employed in this series.

As pointed out above, in all instances where a radiation effusion was observed there was an accompanying radiation pneu-

monitis. This appeared at the same time or slightly earlier—usually by not more than a month or two—than did the pleural fluid. The pneumonitis, as a rule, was located in the upper lobe near the apex, just under the treatment field corresponding to the axillary and supraclavicular ports. Occasionally it was seen in the perihilar region. The parenchymal involvement was noted initially as a zone of hazy opacity superimposed upon patchy, linear, and streaky infiltrations. Early in its development there was no evidence of shrinkage or fibrosis of the upper lobe. In no instance was evidence of parenchymal involvement seen below the level of the hilus, in contrast to the usual location of the fluid collection at the base of the lung field and well outside the zone of pleura and parenchyma receiving the maximum amount of radiation. The degree of pneumonitis varied considerably in the 11 cases. In almost half the patients moderate to marked radiation reactions were shown within the parenchyma of the upper lobe. Again, no definite correlation could be ascertained between extent of involvement and amount of radiation dosage employed in this series.

The 11 cases were followed for periods up to four years with serial radiographic studies. The fate of the fluid was unknown in Case VIII. In 4 of the remaining 10 cases, the effusions disappeared spontaneously after intervals of four to twenty-three months, and there were no recurrences due to irradiation. In the other 6 cases, effusions were still noted after ten, seventeen, twenty-five, thirty, thirty-one, and forty months. Usually the amount of fluid remained the same or showed some decrease. In Case VII there was a slight increase of fluid at thirty months. With one exception, all of the patients remained well, without evidence of disease. In Case XI there was complete disappearance of the fluid at four months, without recurrence until four years later, when a metastatic effusion appeared. In a number of cases thoracenteses were performed and cell blocks of

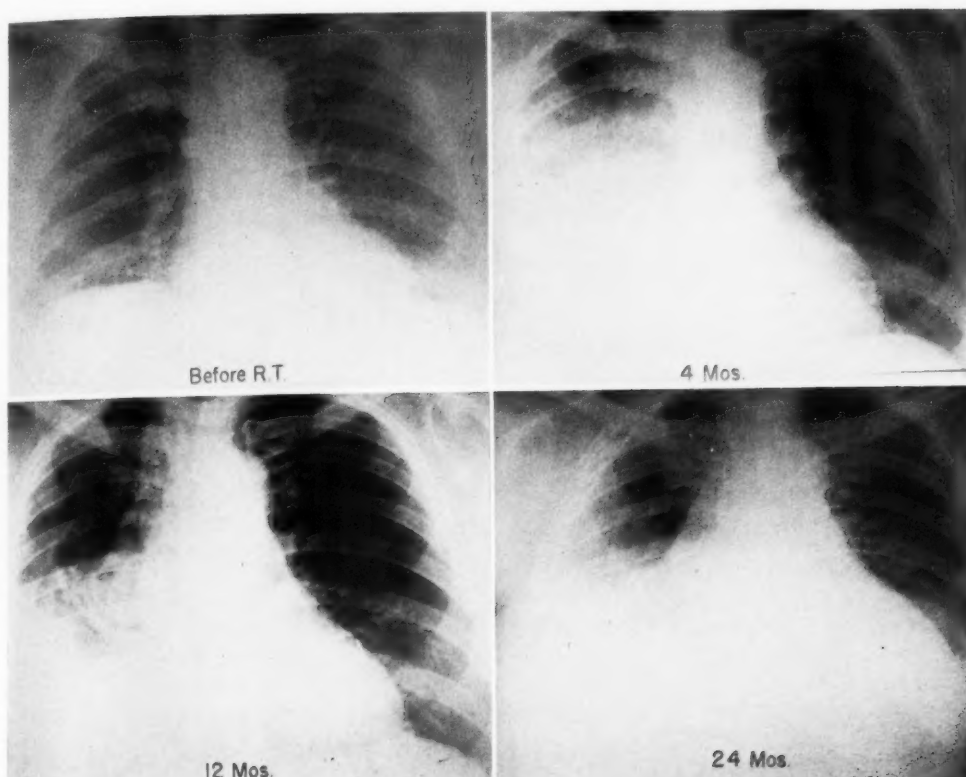


Fig. 1. Case I. Before radiotherapy: normal lung fields.

Four months after completion of radiotherapy: Marked radiation reaction midlung field and considerable pleural effusion.

Twelve months after radiotherapy: significant decrease in amount of effusion and presence of linear, fibrotic strands in the right parahilar lung field. Beginning thickening of the right mediastinal pleura.

Twenty-four months after radiotherapy: no essential change in amount of fluid at right base. Note the distinct thickening of the right mediastinal pleura. The fibrotic strands in the right parahilar lung fields are diminished. The left lung field remains clear.

the fluid were examined for malignant cells, always with negative results. With time, an increasing degree of adhesions, pleural bands, and a tendency toward loculation were generally observed. In the cases where the fluid had completely disappeared there was often a residuum of slightly thickened pleura or some tenting of the diaphragm.

In only 2 instances did the associated pneumonitis disappear. In the remaining cases the radiopneumonitis progressed to fibrosis and shrinkage of the upper lobe, ranging from small, fine, linear strands with minimal shrinkage to a completely airless, shrunken lobe. There was no correlation between the radiation dose or amount of

effusion and the degree of fibrosis and shrinkage. In the 3 cases with complete retraction and opacification of the apices due to radiation, only small or moderate amounts of fluid were evident. In the cases with the largest amounts of basilar effusion, the parenchymal fibrotic changes were comparatively mild.

#### CASE REPORTS

(See also Table I)

CASE I (Fig. 1): M. S., a female aged 49, was admitted to the Francis Delafield Hospital in December 1955 because of a moderately large mass in the right breast, with enlargement of the right axillary lymph nodes and a parasternal swelling on the same side. Biopsies of the breast lesion and parasternal mass showed poorly differentiated car-

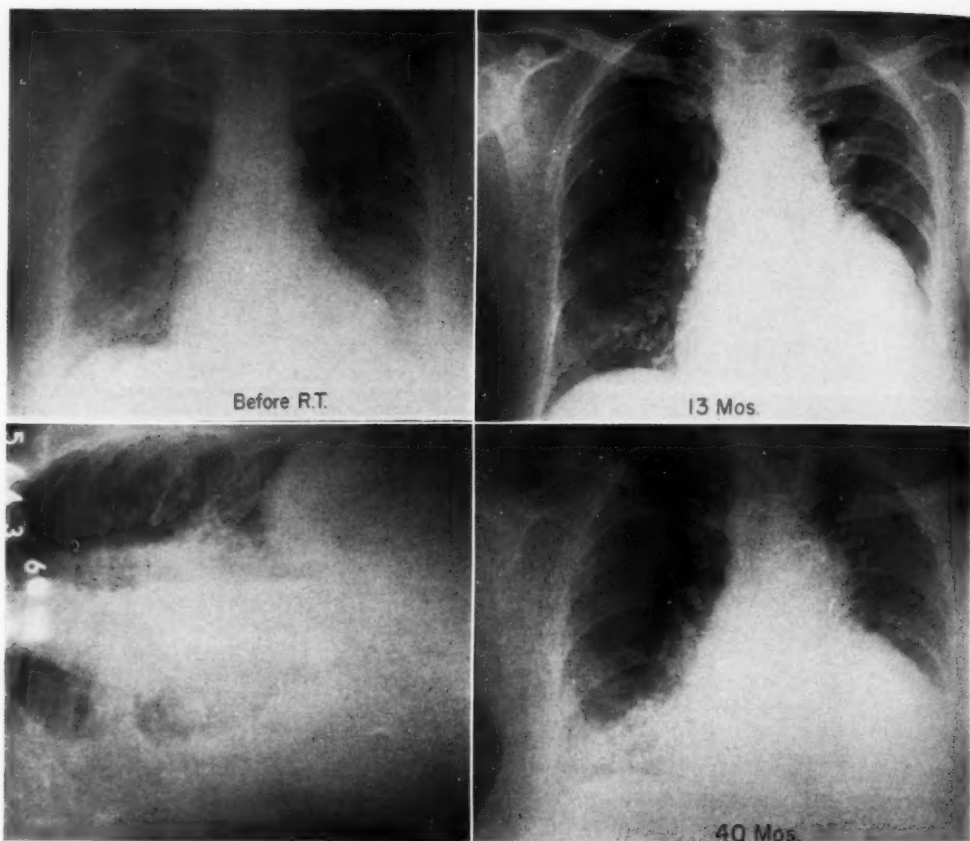


Fig. 2. Case III. Before radiotherapy: normal lung fields.

Thirteen months after radiotherapy. There is a partially loculated effusion at the left base extending into the lower medial portion of the interlobar fissure adjacent to the heart. A mild radiation reaction is still present in the left upper lobe near the hilus.

A lateral recumbent view, also obtained thirteen months after irradiation, shows redistribution of fluid due to change in the patient's position. The interlobar extension of the fluid is clearly evident.

Forty months after radiotherapy: no essential change in the amount and distribution of the interlobar effusion.

cinoma. Two-million-volt radiotherapy was begun on Jan. 23 and completed March 2, 1956, treatment being given through a combined supraclavicular and axillary port, an internal mammary field, and tangential breast ports. Each area received 5,000 r at the tumor-bearing plane. The estimated dose to the adjacent pleura and lung was 5,000 r. The patient has been followed since the completion of radiotherapy and has had no clinical symptoms referable to either the radiation or her breast neoplasm. Twenty-four months following the conclusion of radiation there was no evidence of disease and no complaint referable to the chest.

CASE III (Fig. 2): I. O., a female aged 72, was admitted early in February 1955 with a small tumor in the upper inner quadrant of the left breast and enlarged nodes in the left axilla. Biopsies of the breast, axilla, and internal mammary regions

were all positive, revealing differentiated adenocarcinoma. Radiotherapy at 2 million volts was begun on March 8 and completed on May 11, 1955. Treatment was given to a combined supraclavicular and axillary field for a tumor dose of 4,800 r, an internal mammary field for a dose of 4,400 r, and internal and external tangential breast ports for a tumor dose of 4,200 r. The estimated dose to the adjacent pleura was about 4,400 r. There was no undue reaction to the therapy and there have been no complaints referable to the neoplasm or the radiation during the past three and one-half years. There is no evidence of disease at present.

CASE IV (Fig. 3): B. D., a female aged 44, was admitted in September 1955 with a large tumor occupying the right breast, with large, fixed axillary lymph nodes. Biopsies of the breast, axilla, and internal mammary glands were all positive

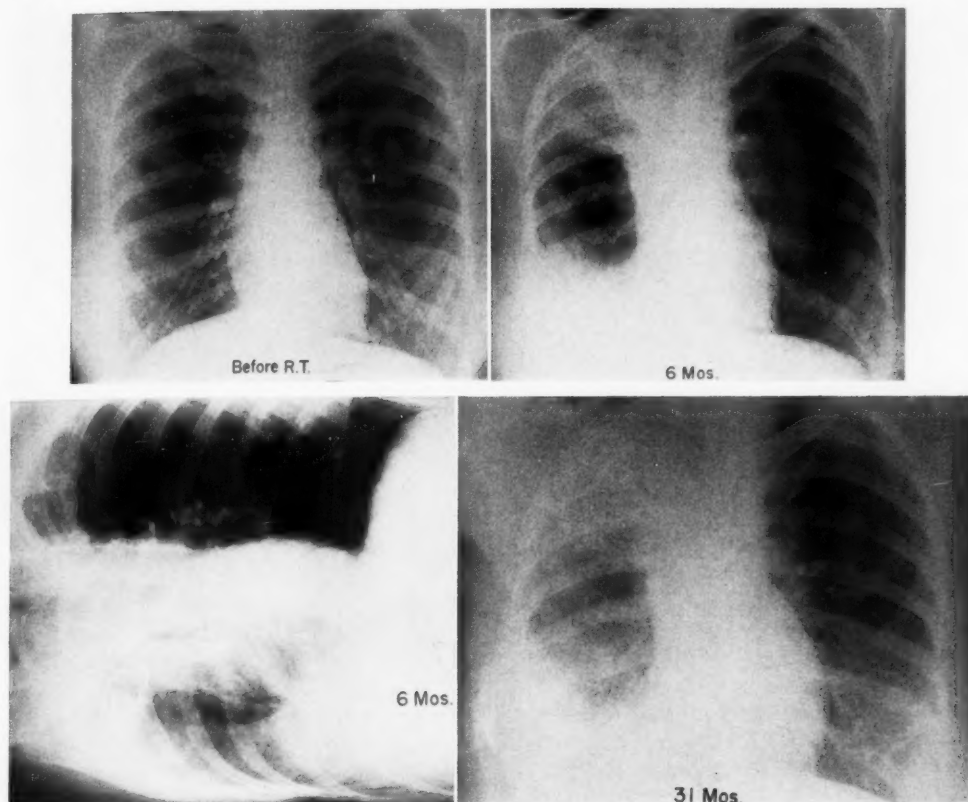


Fig. 3. Case IV. Before radiotherapy: normal lung fields.

Six months after radiotherapy. There is a dense, shrunken, and fibrotic right upper lobe associated with a moderate pleural effusion at the right base.

Right lateral recumbent view also obtained six months after irradiation, showing redistribution of the fluid due to change in the patient's position.

Thirty-one months after radiotherapy. No essential change from the radiographic examination at six months. The left lung remains clear.

for adenocarcinoma. Between Sept. 19 and Oct. 26, 1955, 2-million-volt radiotherapy was given to a combined supraclavicular and axillary field, an internal mammary port, and medial and lateral tangential breast fields. The tumor-bearing plane in each of these areas received 5,500 r. The estimated dose to the adjacent pleura and marginal portion of the lung was 5,500 r. There was no clinical reaction to the radiation therapy. The patient has been followed for three years and at the present time there are no complaints and no clinical evidence of disease.

CASE IX (Figs. 4 and 5): A. G., a female aged 50, was admitted in October 1955 with a large mass in the left breast. Biopsies of the internal mammary region, the supraclavicular area, and the breast mass showed carcinoma only in the breast. A radical mastectomy was done in October 1955. Post-operative radiotherapy at 2 million volts was given

from Dec. 19, 1955, to Jan. 24, 1956. A combined supraclavicular-axillary port and an internal mammary field each received a "tumor" dose of 5,000 r. The adjacent pleura and lung were also estimated to have received 5,000 r. There were no symptoms referable to the radiation and the patient is alive and well without evidence of disease thirty months after treatment.

#### DISCUSSION

The 5 per cent occurrence rate for radiation effusions in the approximately 200 cases that were studied in this series is an accurate but somewhat misleading statistic. In the great majority of the 200 cases there was no effusion at all for at least the first two years following radiation therapy; in a number of cases, fluid ap-



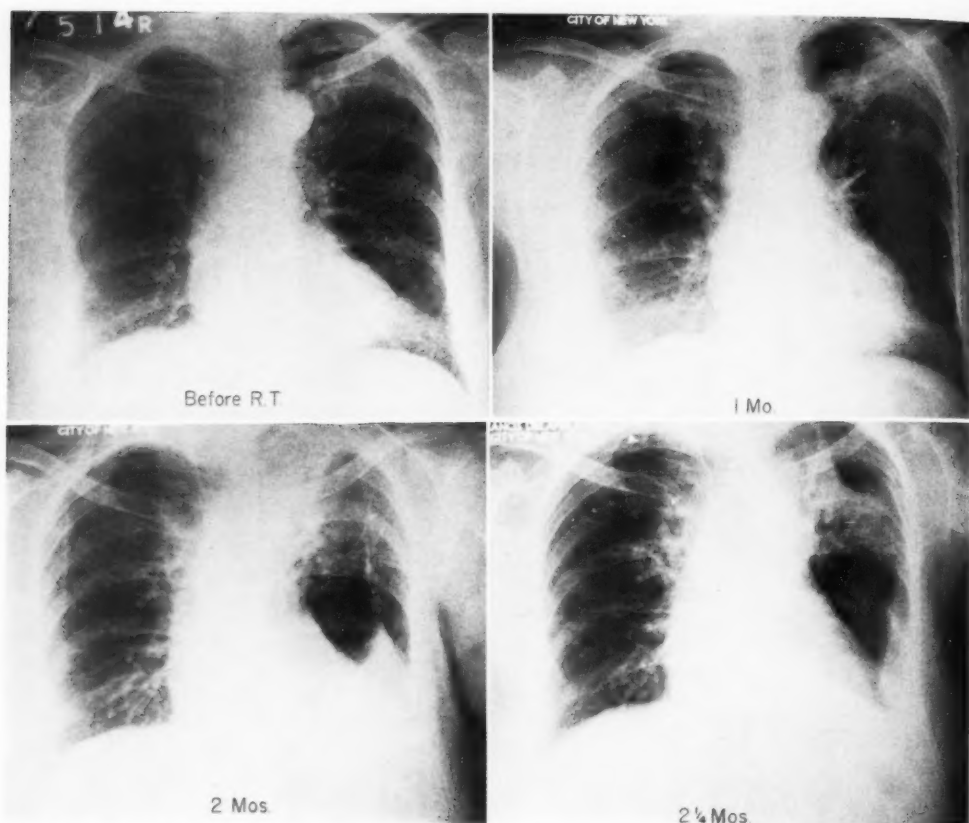


Fig. 4. Case IX. Before radiotherapy: normal lung fields. One month after radiotherapy. There is a mild hazy pneumonitis in the left apex. No evidence of pleural effusion.

Two months after radiotherapy. The radiation pneumonitis in the left apex is much more marked and a localized, loculated effusion is present at the left base.

Two and a quarter months after radiotherapy. Note the distinct regression of the apical infiltration and diminished amount of fluid at the left base.

peared considerably more than a year after the radiotherapy was completed and was associated with other obvious signs of metastasis clearly indicative of malignant disease. On the other hand, the radiation effusions formed a comparatively large group among the cases in which fluid became manifest within twelve to eighteen months following treatment. The finding of this significant number of patients with pleural fluid most probably resulting from high doses of 2-million-volt radiation therefore appears of more than academic interest. Until the present time 200- to 250-kv apparatus has been universally employed for breast carcinoma,

and pleural effusions resulting from this treatment have been encountered so rarely that the development of fluid has been considered as almost definite evidence of metastasis to the pleura and/or lung. With the advent of supervoltage therapy this assumption is less accurate, and the differential diagnosis of metastatic and postirradiation effusions becomes more important. The two most significant factors in differentiation were found to be the time of appearance of the fluid with respect to the radiotherapy and the concomitant presence of a local radiation reaction in the lung parenchyma under the treatment port.

In the great majority of the 11 clear-cut postirradiation cases, the fluid was observed between two and four months after the conclusion of treatment and not once after six months. In all these cases the fluid when first encountered was accompanied by a well established radiation pneumonitis; in no instance did the effusion precede the parenchymal involvement. Our experience therefore indicates that unless these conditions are encountered, the effusion must be considered as probably metastatic. Of importance, also, was the observation that in no case of effusion following radiotherapy was there any fluid on the opposite side. In addition, there were a number of instances in which the fluid had either disappeared or remained constant in amount for comparatively long periods, only to become evident or rapidly reaccumulate later. These late-appearing effusions were always found to be metastatic in character.

The location of the pleural effusions was not of great importance in differential diagnosis. Usually the collections, whether due to radiation or metastases, were found at the base of the pleural cavity. The radiation effusion was frequently loculated and interlobar, but metastatic collections were similarly distributed. We were occasionally impressed, however, by the suggestive appearance of a loculated basilar effusion appearing about two to three months after the conclusion of radiotherapy and associated with tenting of the diaphragm and a patchy or linear fibrotic infiltration in the homolateral apex with varying degrees of pulmonary shrinkage.

The duration of the effusions was a factor of limited significance. In several instances the fluid spontaneously disappeared (in from four to twenty-three months) and the diagnosis of radiation effusion was confirmed. In a considerable number of cases, however, the radiation effusions were found to simulate metastatic collections in persisting for long periods of time—well beyond two years—without significant change in amount or appearance. These persistent effusions were usu-



Fig. 5. Case IX. Ten months after radiotherapy. Almost complete disappearance of the apical pneumonitis and basilar effusion. There remain only fibrotic strands in the apex and pleural thickening at the base.

ally accompanied by residual radiation fibrosis and shrinkage in the apical parenchyma, but occasionally the apical lung reaction would almost completely disappear while the fluid remained.

It is apparent, also, that instances of combined radiation reaction and pleuropulmonary metastases will be encountered. These may cause great difficulty in proper interpretation. The sequential relationship between the roentgenographic findings and the radiotherapy and its dosage as well as the presence of suggestive metastatic manifestations in the pulmonary areas outside the treatment ports or in the opposite lung field are considered the main factors in arriving at an accurate diagnosis.

The cause of the postirradiation effusion and the nature of the pleural reaction have been the subject of some speculation. The pathological investigations of Engelstad (2, 3), Warren and Gates (4, 5), and Henzi (12) were uniform in showing no significant microscopic alterations in the pleura due to radiation, whereas the parenchymal and bronchial effects were extensive, severe, and rather characteristic, leading to marked fibrosis, secondary infection, and pneumonitis with varying degrees of suppuration. These authors also concurred in suggesting that the pleural reaction and effusion (when

present) might well be secondary to the parenchymal inflammation, perhaps complicated by secondary infections. On the other hand, in a considerable number of cases which did well clinically and did not come to autopsy, the effusion persisted for long periods even though the radiation pneumonia completely disappeared and the pulmonary parenchyma appeared entirely normal. Conversely, there were a number of cases with severe radiation pneumonitis reactions, progressing to complete upper lobe fibrosis and shrinkage, in which pleural effusion was never found or was present in only small amounts. Further, a common observation following radiotherapy was diaphragmatic adhesions and tenting, usually without fluid, while the lower lobe immediately adjacent to the tented area appeared entirely clear. In some instances, particularly where tangential chest wall fields were employed, the treatment ports included the diaphragm and its pleura, since these cases were usually treated with the patient supine, so that the dome of the diaphragm rose quite high.

In view of the above considerations, it would be reasonable to conclude that, regardless of the mechanism of production, the radiation must be considered as the actual cause of the effusion, either directly or secondarily. In this respect the investigations of Engelstad are of importance in suggesting that the essential factors causing radiation pulmonary changes are total dose delivered and overall delivery time. With conventional voltages and their marked skin reactions the dose to the lungs (and pleura) rarely exceeded 3,000 to 3,500 r. Even with these quantities, radiopneumonitis was not uncommon and pleural effusions were very occasionally encountered. Primarily because of the marked reduction in skin effects, supervoltage therapy has been carried to considerably higher dosage levels (4,000 r to 6,000 r) in the same period of treatment time. While these increased doses may well have a most salutary effect on possible metastases in the supraclavicular, axillary,

and internal mammary regions, they also carry the risk of greater reactions in the adjacent lung and pleura. It would appear of importance, therefore, to become aware of the increasing incidence of augmented pleuropulmonary reactions in supervoltage therapy in order to avoid errors of diagnosis and the possibility of giving additional radiation in cases where radiopleuropneumonitis is mistaken for metastatic cancer.

#### SUMMARY

Pleural effusions most probably due to radiation were observed in 5 per cent of about 200 cases of carcinoma of the breast treated with 2-million-volt radiotherapy either postoperatively or, in inoperable cases, as the primary form of therapy. This group of 11 cases formed a considerably greater percentage of the cases in which a pleural effusion appeared within eighteen months following irradiation, and the problem of differential diagnosis between radiation and metastatic effusions was often a difficult one. The observations of distinct aid in differentiation were as follows: (a) In all instances radiation effusions appeared within six months following completion of the radiotherapy, often within two to four months. (b) In all cases the effusion was accompanied by a radiation pneumonitis. (c) Spontaneous disappearance of fluid indicated that it was probably due to radiation. (d) Where the fluid had disappeared or remained stationary in amount for considerable periods of time and then rather suddenly reappeared or increased in amount, the cause of the re-accumulation was found to be metastases. On the other hand, the radiographic appearance and persistence of the effusions were not found significantly helpful in differentiating the two conditions. In both groups the fluid was found either loculated or in the free pleural cavity, and in both types the effusions were observed to persist more or less unchanged in amount for long periods of time.

The relationship of the radiation effusions to conventional and supervoltage

radiotherapy, total dose delivered, and radiopneumonitis is discussed. Finally, a summary table of the 11 cases and more detailed reports of 4 cases with representative roentgenograms are presented.

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#### SUMMARIO IN INTERLINGUA

##### Effusiones Pleural Post Radiation A Supervoltage Pro Carcinoma Mammari

Le presente reporto se basa super un revista del serial roentgenogrammas thoracic de approximativemente 200 casos de carcinoma mammari in le quales radiotherapia a 2 milliones volt esseva administrate. Effusiones pleural debite le plus probabilemente a radiation esseva observate in 11 (5 pro cento) de iste casos. In differentiar inter effusiones radiational e effusiones metastatic, le sequente observationes se provava de distincte valor: (1) In omne casos le effusiones radiational appareva intra sex menses post le completion del radiotherapia, frequentemente intra duo o quatro menses. (2) In omne casos le effusion esseva accompagnate de un pneumonitis de radiation. (3) Disparition

spontanee de fluido indicava que illo esseva probabilemente debite a radiation. (4) Ubi le fluido habeva disparite o habeva remanite stabile in quantitate durante periodos considerabile de tempore e allora reappareva e se augmentava in quantitate plus o minus subitemente, le causa del reaccumulation esseva trovate in le metastases. Del altere latere, le aspecto radiographic e le persistentia del effusiones non se monstrava significativamente utile in differentiar le duo conditiones. In ambe gruppos le fluido esseva trovate in loculos o in le libere cavitatie pleural, e in ambe typos le effusiones persisteva plus o minus sin alteration durante longe periodos de tempore.

# Arteriovenous Fistula of the Lung<sup>1</sup>

LIEUT. BILLY P. SAMMONS, MC, USN

**P**ULMONARY arteriovenous fistulas are anomalous connections between the arteries and veins of a portion of the pulmonary vascular bed. Since the first clinical diagnosis of pulmonary arteriovenous fistula by Smith and Horton in 1939 (13), 200 cases have been reported. The detection by routine chest roentgenograms and photofluorograms of clinically silent spheroid pulmonary lesions has been largely responsible for an increasing frequency of diagnosis. It is now mandatory that a radiologist, confronted with a density in the lung parenchyma, include arteriovenous fistula in the differential diagnosis. This is of prime importance, since the surgical approach may differ from that for the usual "coin lesion."

## CASE REPORTS

**CASE I:** On Feb. 15, 1958, a 27-year-old Caucasian sailor was admitted to the St. Albans Naval Hospital. A routine chest roentgenogram for discharge from the service revealed a density in the right lower lobe. History and physical examination were unremarkable. A murmur within the right chest could not be detected and examination of the mucous membranes and skin failed to reveal telangiectasia.

There was no history of familial disease. Oxygen saturation and pulmonary function studies were normal. The roentgenograms are shown in Figures 1-4.

A segmental resection of the fistula in the right lower lobe was performed with an uneventful post-operative course.

**CASE II:** A 24-year-old Caucasian sailor was admitted to the U. S. Naval Hospital in December 1955 because of a mass in the left lung, detected on an annual chest roentgenogram. He was asymptomatic and had never had any operation or serious illnesses. System review and familial history were unremarkable. Physical examination failed to reveal telangiectasia or other abnormalities except for a soft, sharply localized systolic murmur in the left posterior axillary line over the eighth rib. This did



Fig. 1. Case I. Postero-anterior roentgenogram of the chest demonstrates an irregular density in the right lower lobe with large vessels radiating from the hilus toward the lesion.

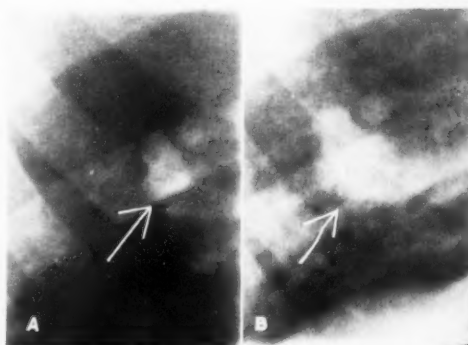


Fig. 2. Case I. Valsalva (A) and Müller (B) maneuvers show the compressible nature of the lesion.

not change with respiration. Results of laboratory studies were within normal limits. Oxygen saturation of the arterial blood was normal. Roentgen studies are shown in Figures 5-7.

<sup>1</sup> From the Department of Radiology, U. S. Naval Hospital, St. Albans, N. Y. Accepted for publication in June 1958.

The opinions expressed herein are those of the author and do not necessarily represent the views of the Bureau of Medicine and Surgery, Navy Department.



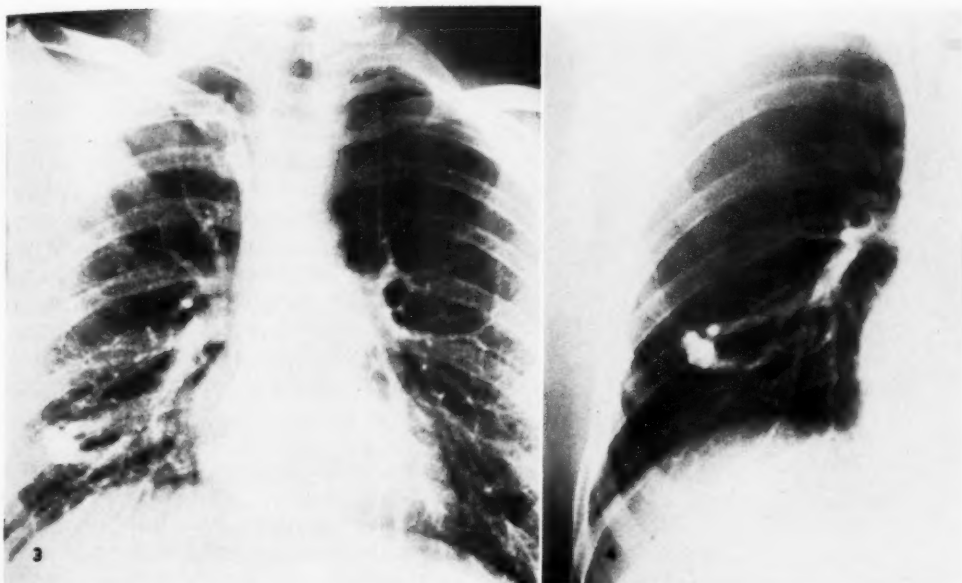


Fig. 3. Case I. Angiocardiography demonstrates the vascular nature of the mass, and excludes other fistulas.

Fig. 4. Case I. Serial studies of the contrast-filled fistula identify the afferent and efferent vessels as an aid to segmental resection.

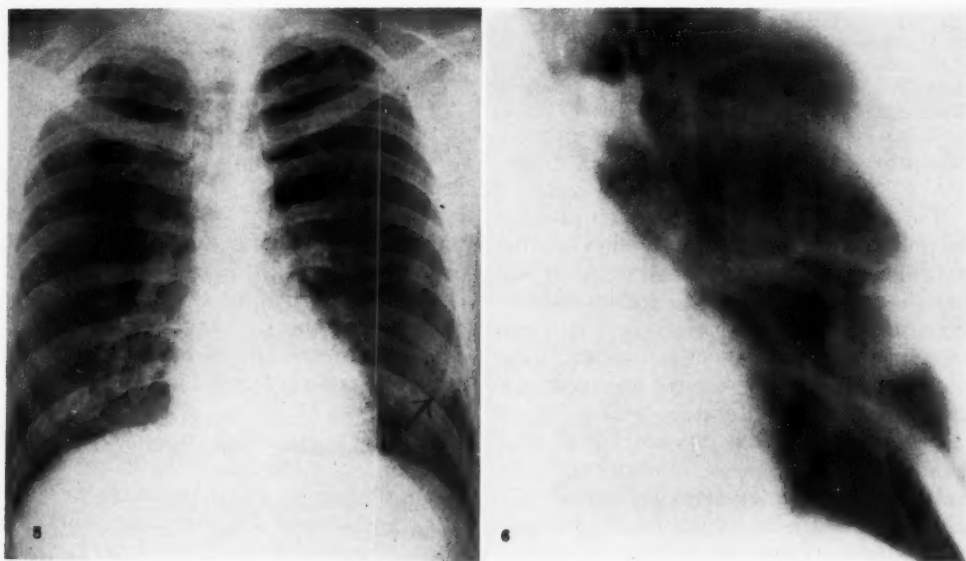


Fig. 5. Case II. Postero-anterior roentgenogram of the chest reveals a spheroid density in the left lower lobe with a large vessel radiating from the hilus toward the lesion.

Fig. 6. Case II. Tomography reveals a large vessel in the same plane as the pulmonary mass apparently entering the lesion.

At surgery, a wedge resection removed the fistula intact and no murmurs or thrills were detectable in the remaining lung. The postoperative course was uneventful.

CASE III: A 33-year-old Caucasian female was admitted to the St. Albans Naval Hospital in September 1945. During a bout of acute tonsillitis a chest roentgenogram revealed a mass in the left

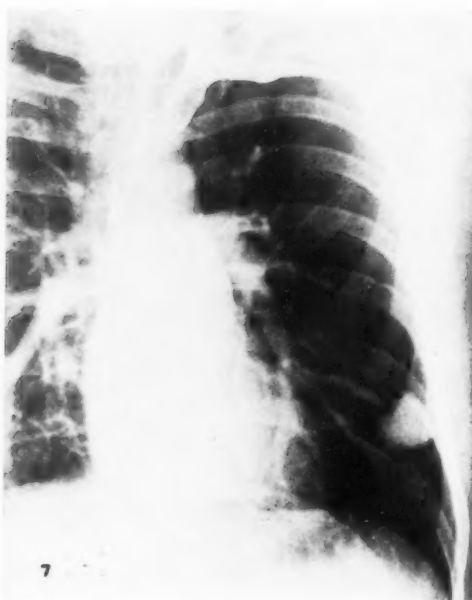


Fig. 7. Case II. Angiocardiography confirms the diagnosis, identifies the afferent and efferent vessels as an aid to segmental resection, and excludes other fistulas.

lung, adjacent to the hilus. History and physical examination were otherwise unremarkable and there were no familial diseases. Angiocardiography confirmed the diagnosis of a pulmonary arteriovenous fistula but surgery was refused by the patient.

#### REVIEW OF LITERATURE

Three years after the first description of a pulmonary arteriovenous fistula successful surgical removal of the anomaly had been reported (4, 11), and today the surgical technic presents no problem if a correct preoperative diagnosis is made. The nomenclature has not enjoyed such success, and current literature still refers to these malformations as congenital pulmonary arteriovenous aneurysms (12), pulmonary arteriovenous fistulae (7), pulmonary angiomatous malformations (15), hemangiomas of lung (17), angiomatosis of the lung (2), telangiectasia of the lung (1), and cavernous pulmonary telangiectasia (3). Pulmonary arteriovenous fistula is the preferable designation, since it describes the pathologic feature of a shunt from a pulmonary artery to vein without the normal capillary bed.

Sloan and Cooley (12), by reviewing 85 cases collected from the literature up to 1953, are probably responsible for publicizing this entity, since over 100 cases were reported in the next three years, more than had been recorded in the previous fourteen years. The association of hereditary hemorrhagic telangiectasia with arteriovenous fistula was described in 1948 by Moyer (6). This has since been found in 30 per cent of the reported cases. The importance of angiocardiography was discussed by Robb (10) as early as 1946 and subsequently emphasized by Steinberg (14).

#### CLINICAL ASPECTS

At the St. Albans Naval Hospital, a 1,200-bed hospital, 8 cases of arteriovenous fistula of the lung have been diagnosed and operated upon in the past seven years. Seven patients were males and all were of the Caucasian race. The reported cases have not shown any significant sex or race predilection. Fifteen per cent of patients with pulmonary arteriovenous fistula have a familial history of Rendu-Osler-Weber's disease and 40 per cent have telangiectatic lesions elsewhere in the body.

Most patients without complications are asymptomatic. Dyspnea is noted in less than one-third of the cases and is probably dependent on a large flow of unoxygenated blood into the systemic circulation. Physical findings consist of cyanosis, clubbing of fingers and toes, and a bruit over the site of the fistula. Polycythemia is found in a high percentage of patients.

Complications of a neurologic nature are not uncommon. These consist of brain abscesses, acute meningo-encephalitis, and cerebral thrombosis from the polycythemia. Fatal hemoptysis has been reported but is less common than neurologic complications. The resemblance of the clinical findings to those of cerebral abscess and metastases from lung carcinoma and the roentgen similarity to solitary lung tumors must be remembered, as improper diagnosis can be disastrous.

## ROENTGEN FINDINGS

A spheroid density in the lung with prominent vessels entering the lesion is the most characteristic roentgen picture. However, the afferent and efferent vessels may not be visible on conventional chest roentgenograms, the lesion may be so small as to be barely discernible, and the periphery may be so ill defined as to simulate an infiltrate rather than a vessel or tumor. Any segment of the lung may be involved and calcification is rare. These variable findings require a high index of suspicion for all lung or hilar densities and a routine of evaluation is necessary for any suggestive lesion. Fluoroscopy is the simplest procedure and the one employed initially at this hospital. At this examination pulsation can be observed and changes in size of the lesion detected with the Müller and Valsalva procedures. The former increases and the latter decreases the size, due to the change in intrathoracic pressure. Tomography is then employed for better evaluation of the relationship of vessels to the pulmonary lesion. If the possibility of a fistula has not been entirely excluded by these procedures, or if a fistula is definitely established, angiocardigraphy is immediately utilized, unless a history of iodine sensitivity is elicited or cyanotic congenital heart disease is present. In a series of over 800 angiocardigrams in the past eight years there has been a single death, in a cyanotic five-year-old child with congenital heart disease. Cardiac arrest occurred during induction of Vinethene anesthesia. Demerol alone is now employed in children and no premedication or anesthesia is given to adults. Angiocardigraphy includes simultaneous postero-anterior and lateral films at three and six seconds to detect multiple or bilateral lesions not apparent on previous studies. If a fistula is demonstrated, a second injection is made and serial films are exposed at 0.5-second intervals. By this means the exact arterial supply and venous flow are outlined and systemic feeders or chest wall involvement by the

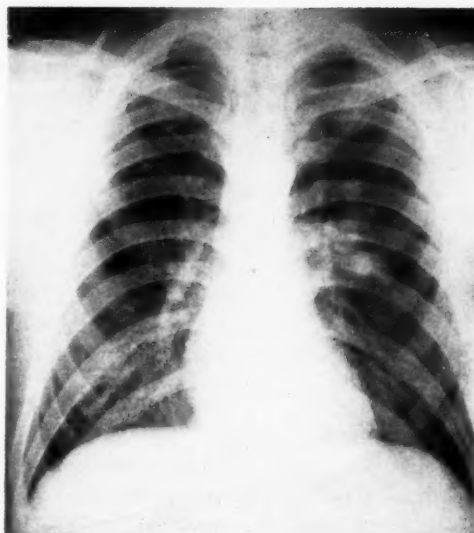


Fig. 8. Case III. Postero-anterior roentgenogram of the chest shows numerous large cylindrical densities adjacent to the left hilus. Subsequent angiocardigraphy demonstrated an arteriovenous fistula, but surgery was refused because of the probability of a pneumonectomy being required to eradicate the lesion.

pulmonary arteriovenous fistula are detected, as has been reported (16).

It is interesting that hamartomas have presented the largest number of suspicious roentgenograms necessitating angiocardigraphy to exclude a pulmonary vascular malformation.

## PATHOLOGY

The spheroid density seen on the roentgenogram represents a thin-walled sac usually lying just beneath the visceral pleura. Any segment of any lobe may be involved and 20 per cent of the lesions are bilateral or involve two lobes on the same side. The arterial blood supply and venous drainage are usually by way of a pulmonary artery and vein of the involved lobe. However, bizarre supply and drainage may occur. The artery may be from another lobe, the aorta (16), or intercostal artery (5). Veins from adjoining lobes may drain the fistula or it may be drained by completely anomalous veins. The vascular structure of the resected specimen is best demonstrated by use of a fusible metal casting (8).

Microscopically the wall of the sac has the characteristics of the thin-walled dilated capillaries and venules found in hereditary hemorrhagic telangiectasia (Rendu-Ösler-Weber disease). When a pulmonary arteriovenous fistula is associated with this generalized disease, the other telangiectases may be found in mucous membranes, skin, and various viscera.

#### THERAPY

When the diagnosis is made, therapy consists of surgical excision, as much normal lung as possible being left to preserve pulmonary function. Even in asymptomatic patients the dangers of serious complications far outweigh the minimal risk of modern segmental resection or lobectomy. Angiocardiography, which demonstrates the exact location of afferent and efferent vessels, has greatly decreased the chance of incomplete resection of a fistula or of missing multiple fistulas.

#### SUMMARY

The increasingly frequent detection of pulmonary lesions necessitates the routine inclusion of pulmonary arteriovenous fistula in the differential diagnosis. The presence of "feeders" in the region of the lesion strongly suggests its possibility. Fluoroscopy, tomography, and angiocardiography will detect all but minute pulmonary telangiectasias and will give the necessary information for proper surgical attack. Symptoms consist of dyspnea, cyanosis, and clubbing of digits. Examination may reveal polycythemia, a murmur over the pulmonary lesion, and telangiectasia of skin and mucous membranes. Complications of hemoptysis, meningoencephalitis, cerebral thrombosis, and brain abscess may be presenting complaints. Because of the occurrence of these extremely serious complications, sur-

gery is the treatment of choice even in asymptomatic individuals.

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## SUMMARIO IN INTERLINGUA

## Fistula Arterio-Venose Del Pulmon

Al Hospital Naval St. Albans, que ha 1.200 lectos, 8 casos de fistula arteriovenose del pulmon esseva diagnosticate e tractate chirurgicamente durante le passate septe annos. Tres del 8 es reportate.

Es sublineate le importantia de recognoscer iste communicationes anormal per medios roentgenologic. Le presentia de "alimentatores" in le region del lesion suggere fortemente le diagnose. Per medio de fluoroscopia, tomographia, e angiocardigraphia, on pote deteger omne le telangiectases excepte le minute pulmonares e obtener le information necessari pro le

appropriate attacco chirurgic. Le symptomas consiste de dyspnea, cyanosis, e digitos de Hippocrates. Le examine pote revelar polycythemia, un murmure supra le lesion pulmonar, e telangiectasis del pelle e membranas mucose. Le gravamines con que la patiente se presenta pote esser complicationes como hemoptysis, meningoencephalitis, thrombose cerebral, e abscesso cerebral. A causa del possibilitate de iste gravissime complicationes, intervention chirurgic es le tractamento de election mesmo in individuos asymptomatic.





## Agnogenic Myeloid Metaplasia<sup>1</sup>

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**A**GNOGENIC myeloid metaplasia may best be defined as a disorder involving hematopoiesis outside the usual marrow sites, most frequently accompanied by fibrosis of the marrow. This condition represents a distinct clinical-hematologic-roentgenologic entity, with characteristic features.

The literature dealing with this disease is voluminous and confused. References are made to primary and secondary forms and some investigators have even considered it to be a variant of leukemia, including it among the "myeloproliferative disorders." Synonyms include "pseudoleukemia with splenic-cachexia," "osteosclerosis with myelofibrosis," "splenic pseudoleukemia," "aleukemic myelosis," "myeloproliferative syndrome," "myeloid metaplasia," "pan-myelosis," "megakaryocytic myelosis," etc. The term *agnogenic myeloid metaplasia* is becoming increasingly acceptable. It is not within the purview of this presentation to review and evaluate the entire literature. Some of the classic articles which may best be read in the original are those by Jackson, Parker, and Lemon (3); Korst *et al.* (4); Sussman (8); Windholz and Foster (12); Mulcahy (5); Block and Jacobson (1); Green *et al.* (2); Wasserman (11); Rosenthal (6); and Rosenthal and Erf (7).

### CLINICAL AND HEMATOLOGIC FINDINGS

When the patient first presents himself for medical evaluation, he is usually seen with the following clinical and hematologic picture:

The history is often vague and nonspecific. Complaints may include fatigue, fullness in the abdomen, and sometimes hemorrhagic symptoms. On physical examination, pertinent findings are usually pallor

and hepatosplenomegaly. In the blood work-up, two striking abnormalities are generally found in the peripheral smear which must always suggest the possibility of this disorder. These are: (a) nucleated red cells and (b) young members of the neutrophilic series. Anemia of the normocytic and normochromic type is frequently, but not necessarily, present. The platelet count is variable; it may be normal or reduced, but often there is a striking thrombocytosis. The white count ranges from an extreme leukopenia to leukocytosis, so that a true leukemia may be suspected. Because of the occasional leukocytosis and because of the polycythemic phase that may precede this disorder, there have been attempts to classify the disease with the leukemias.

Bone marrow usually cannot be aspirated. Only after surgical removal of a section of bone marrow, or upon biopsy of a section of bone from such areas as the iliac crest, is it possible to establish histologically the presence of a typical myelofibrosis picture, which is the signature of this disorder.

### ROENTGEN FINDINGS

The roentgen appearance has been generally described as a widespread, diffuse, overall increase in bone density. Usually involved are the major long bones of the upper and lower limbs, the pelvic girdle, the thoracic cage, and the spine—mostly the dorsal and lumbar segments. The osteosclerosis may vary in degree from mild to severe. Sussman (8) emphasized the presence of an overall ground-glass appearance of the bones and stated that there may be a uniform increase in density or patchy areas of condensation with small rounded zones of radiolucency frequently noted.

<sup>1</sup> From the Division of Diagnostic Radiology, the Division of Laboratories, and Department of Hematology, Montefiore Hospital, and the Department of Radiology, New York University College of Medicine, New York, N. Y. Accepted for publication in August 1958.

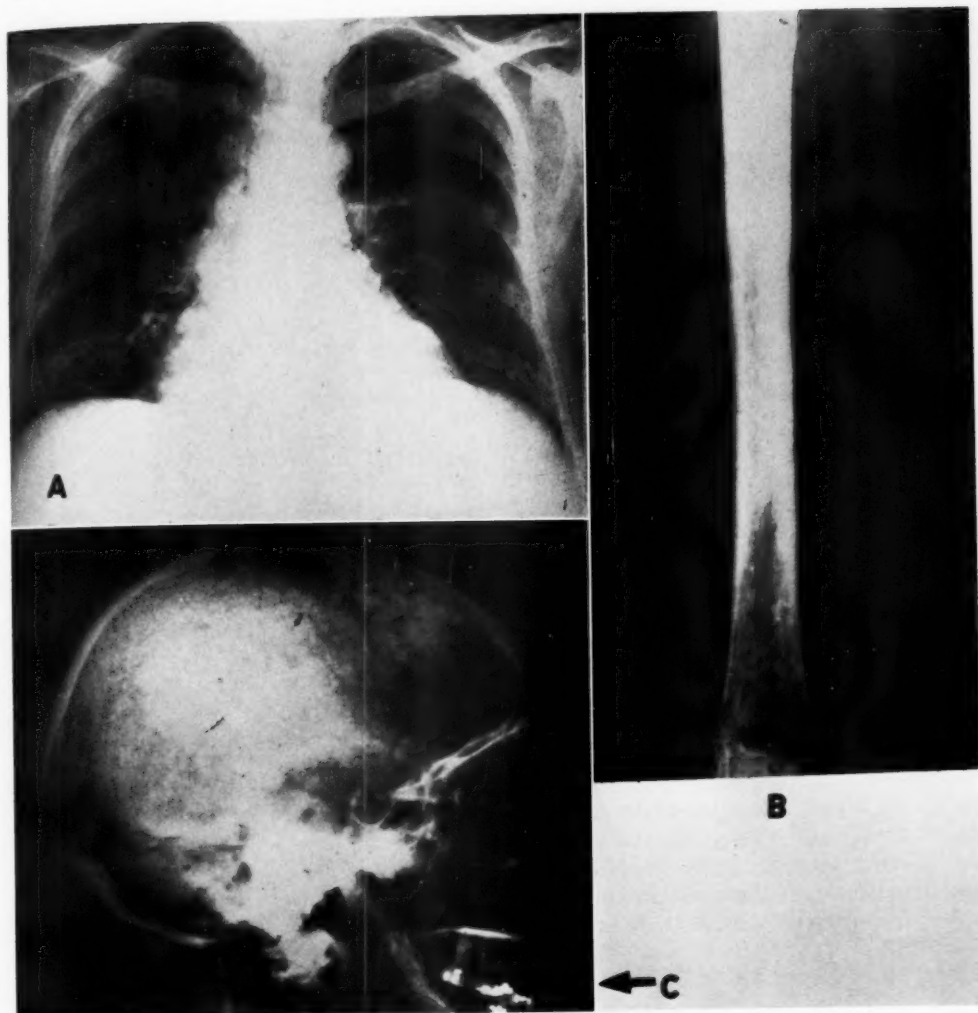


Fig. 1. Case 1.

- A. Frontal plane view of the chest showing an increase in bone density with variegated zones of mottling, involving the bones of the thoracic cage, clavicles, and shoulder girdles. The left diaphragmatic leaflet is slightly elevated due to an enlarged spleen.
- B. Right femoral shaft, showing changes similar to those in the thoracic cage.
- C. Lateral skull roentgenogram showing increase in density with radiolucent mottling throughout the bones of the calvarium.

#### PATHOLOGY

At autopsy, the characteristic marrow picture is that of extensive replacement of normal elements by fibrous connective tissue. In some cases, despite virtually complete absence of hematopoietic elements in the bone marrow, large numbers of megakaryocytes may be seen. With the extensive fibrosis in the marrow, there

may be an accompanying increase in the size of the bony trabeculae with varying degrees of reactive osteosis. Vaughan and Harrison (10) report that the cortical bone may show decreased density, accompanied by subperiosteal new bone formation. Bone resorption, with alteration of the compact corticalis into spongy bone and reduction of the spongiosa, is a

TABLE 1: TWENTY CASES OF AGNOGENIC MYELOID METAPLASIA

No. and Initials	Age and Sex	Size of Liver	Size of Spleen	Blood Picture	Sites of Bone Involvement	Types of Bone Involvement	Special Features of Bone Involvement	Course	Proof
1 A. S.	60 M	Moderately enlarged	Markedly enlarged	Marked anemia, leukopenia, and thrombocytopenia Characteristic smear	Upper and lower limb bones	Overall increase in bone density (from roentgen reports—films not available)	None	Died	Sternal puncture at autopsy and section from lumbar vertebrae showed osteosclerosis
2 M. J.	51 F	Moderately enlarged	Moderately enlarged	Anemia, and leukocytosis Normal platelets No abnormal cells in smear	Upper and lower limb bones including hands, entire spine, pelvis, skull, and thoracic cage	Spotty overall increase in bone density with linear and nodular components and interspersed radiolucent zones. Skull involvement including mandible, maxilla, and petrous pyramids	Osteoporosis circumscripta-like lesion in left iliac bone Increased density in pedicle of L-2 and in spongiosa of proximal and middle phalanges of hands	Alive	Bone marrow biopsy: myelofibrosis and osteosclerosis
3 C. R.	72 M	Moderately enlarged	Moderately enlarged	Moderate anemia and leukocytosis and moderate increase in platelets Characteristic smear	Upper and lower limb bones including hands and feet, entire spine, pelvis, thoracic cage, shoulders	Diffuse widespread uniform increase in bone density	Skull uninvolved except for increase in density in petrous pyramids Uricemia with gout-like changes in first toes	Alive	Bone marrow biopsy: myelofibrosis and osteosclerosis
4 C. L.	68 F	Moderately enlarged	Moderately enlarged	Marked anemia and leukopenia Normal smear	Femoral and humeral shafts, pelvis, entire spine, and thoracic cage	Diffuse mottled increase in bone density with interspersed radiolucent areas throughout	Bizarre periosteal new bone formation in lower ends of femoral shafts. Increase in pedicular density in upper lumbar spine	Died	Autopsy: myelofibrosis, osteosclerosis; extramedullary hematopoiesis in liver, spleen, and lymph nodes; exogenous hemosiderosis
5 M. R.	63 M	Markedly enlarged	Markedly enlarged	Moderate anemia and leukocytosis Platelets normal to low Characteristic smear	Upper and lower limb bones with hands and feet, entire spine, pelvis, thoracic cage, shoulder girdles, and skull	Same changes as in Case 2	Periosteal new bone involving femoral shafts, tibiae, and fibulae Slight cortical thickening in humeral and femoral shafts	Alive	Bone marrow biopsy of iliac crest: myelofibrosis and osteosclerosis. Spleen biopsy: myeloid metaplasia with myelogenous leukemia
6 B. M.	60 F	Moderately enlarged	Moderately enlarged	Mild anemia and slight leukocytosis Characteristic smear	Humeral and femoral shafts, thoracic cage, dorsal spine	Diffuse, uniform, blotchy increase in bone density	None	Died	Biopsy of sternal marrow and iliac crest: myelofibrosis. Autopsy showed similar findings in iliac crest and vertebral body. Nests of leukemic cells in bone marrow

(Table continued on p. 720)



Fig. 2. Case 5.

A. Frontal plane roentgenogram of the abdomen showing hepatosplenomegaly with widespread diffuse increase in bone density involving the pelvic girdle, lumbar spine and lower rib cage.

B. Frontal plane view of knees revealing overall increase in bone density with distinct periosteal new bone formation along lower margins of each femoral shaft.

not uncommon finding, with simultaneous laying down of new bone. ("Osteoid seams" are rare.)



Fig. 3. Case 9. Chest film showing the second type of bone involvement described in the text, with blotchy zones of increased density interspersed throughout the rib cage, clavicle, and shoulder girdles.

The other findings of significance are seen in those organs which are the sites of extramedullary blood production. Foci of extramedullary hematopoiesis are found primarily in the liver and spleen, but sites of hematopoietic tissue have also been noted in a large variety of organs including the adrenals, skin, choroid plexus, and lymph nodes. Changes due to hemorrhage may be noted, such as periosteal elevation with new bone formation. The effect of large numbers of transfusions frequently given in treatment may result in transfusion hemosiderosis.

#### CLINICAL MATERIAL

We have collected 20 cases of agnogenic myeloid metaplasia in which the diagnosis was established by bone biopsy or at autopsy. The data on these cases are presented in Table I, with information as to age, sex, race, presence of hepatosplenomegaly, pertinent blood picture, sites and types of bone involvement, special features in each case, the course, and the manner of proof. In these cases, the following criteria generally applied:

TABLE 1: TWENTY CASES OF AGENIC MYELOID METAPLASIA (Continued)

No. and Initials	Age and Sex	Size of Liver	Size of Spleen	Blood Picture	Sites of Bone Involvement	Types of Bone Involvement	Special Features of Bone Involvement	Course	Proof
7 E. M.	63 M W	Moderately enlarged	Moderately enlarged	No significant anemia No sign of abnormality in RBC, WBC, or platelet count Characteristic smear	Humeral and femoral shafts, pelvis, and spine	Diffuse mild increase in bone density with radiolucent zones interspersed in pelvis. Humeral and femoral shafts, uniform increase in density	Cortical thickening; periosteal new bone in femoral and humeral shafts	Alive	Bone marrow biopsy of iliac crest and sternum: myelofibrosis
8 M. S.	42 F W	Normal	Normal	RBC and WBC normal Platelet count elevated Characteristic smear	Femoral and humeral shafts, dorsal and lumbar spine, pelvis, thoracic cage, and skull	Diffuse, widespread increase in bone density. Thickening of cortices of humeral shafts	None	Alive	Iliac crest biopsy: myelofibrosis and osteosclerosis
9 C. C.	63 F W	Mildly enlarged	Moderately enlarged	Mild anemia Normal WBC and platelets Characteristic smear	Dorsal and lumbar spine, pelvis, thoracic cage, and shoulder girdles	Blotchy increase in bone density throughout, with interspersed zones which are very prominent	Marked prominence of radiolucent zones	Alive	Iliac crest biopsy: myelofibrosis and osteosclerosis
10 H. S.	70 M W	Moderately enlarged	Markedly enlarged	Moderate anemia Normal WBC, thrombocytopenia Characteristic smear	Distal humeral shafts, left radius and ulna, lumbar spine, pelvis, and thoracic cage	Diffuse increase in bone density with slight radiolucent mottling, more marked in thoracic cage	None	Died	Biopsy of iliac crest suggestive of myelofibrosis. Autopsy: myelofibrosis and osteosclerosis
11 J. H.	63 M W	Moderately enlarged	Markedly enlarged	Anemia, leukocytosis, and thrombocytosis Characteristic smear	Pelvis	Diffuse increase in bone density	Extramammary hematopoiesis of liver, spleen, and lymph nodes	Died. Autopsy	Myelofibrosis and osteosclerosis of bone marrow. Extramedullary hematopoiesis of liver, spleen, and lymph nodes
12 F. W.	68 F W	Moderately enlarged	Markedly enlarged	Severe anemia Normal WBC and platelets Characteristic smear	Upper limb bones including metacarpals, femoral shafts, pelvis, thoracic cage, shoulders, and skull	Diffuse increase in bone density with radiolucent mottling in all bones	Radiolucent mottling in skull with thickening of diploë. Hemosiderin deposits in spleen	Died	Bone marrow biopsy: osteosclerosis and myelofibrosis. Autopsy: similar findings plus extramedullary hematopoiesis. Hemosiderin deposits in spleen
13 H. F.	59 M W	Moderately enlarged	Slightly enlarged	Moderate anemia, leukocytosis, and thrombocytopenia Characteristic smear	Femoral shafts, lower lumbar spine, pelvis, thoracic cage, and right shoulder	Mottled increase in bone density with interspersed radiolucent zones	Polycythemia vera for 6 years before development of agnogenic myeloid metaplasia	Died	Bone marrow biopsy and autopsy: myelofibrosis and osteosclerosis

Table Continued on p. 722



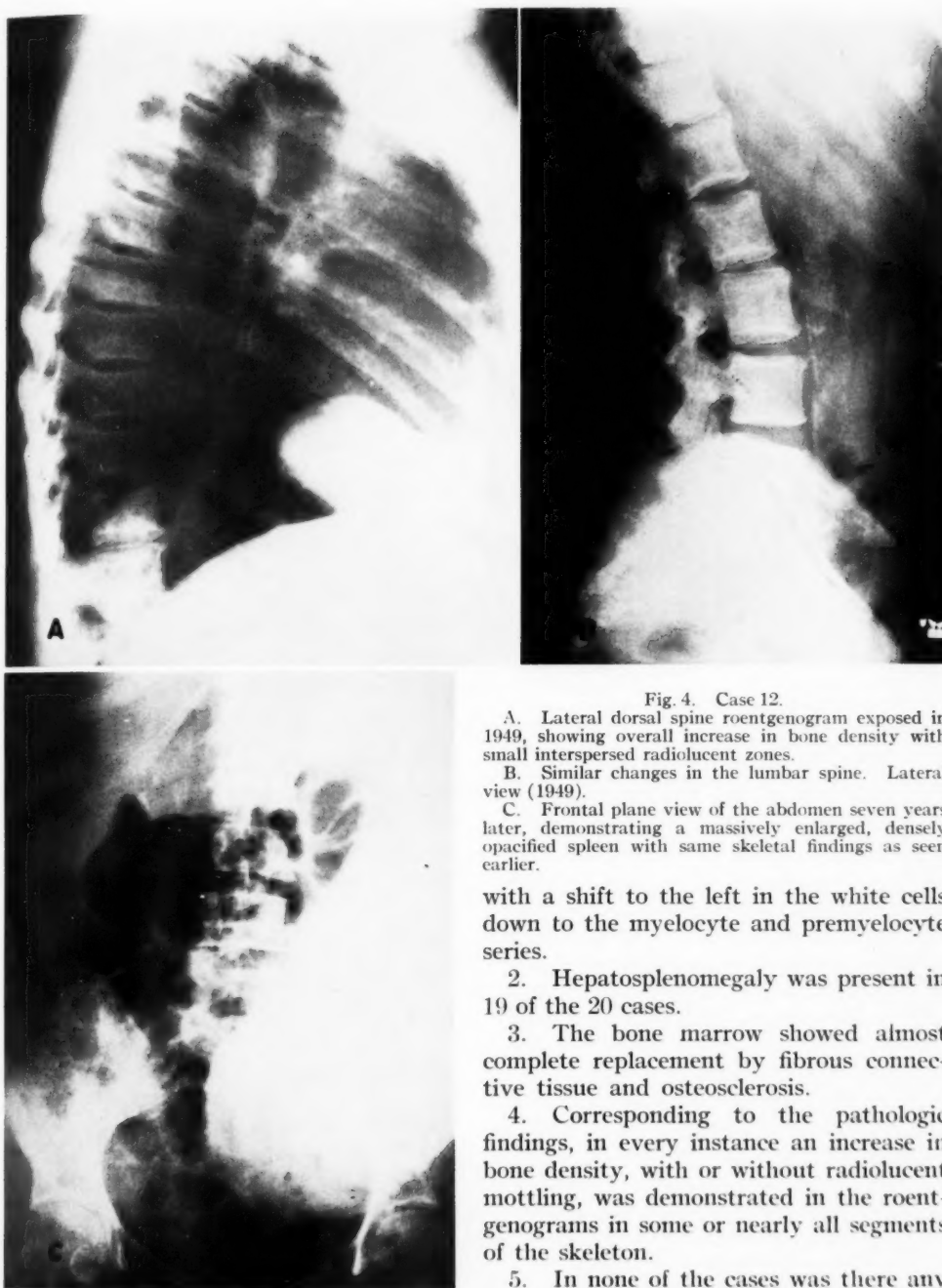


Fig. 4. Case 12.

A. Lateral dorsal spine roentgenogram exposed in 1949, showing overall increase in bone density with small interspersed radiolucent zones.

B. Similar changes in the lumbar spine. Lateral view (1949).

C. Frontal plane view of the abdomen seven years later, demonstrating a massively enlarged, densely opacified spleen with same skeletal findings as seen earlier.

with a shift to the left in the white cells down to the myelocyte and premyelocyte series.

2. Hepatosplenomegaly was present in 19 of the 20 cases.

3. The bone marrow showed almost complete replacement by fibrous connective tissue and osteosclerosis.

4. Corresponding to the pathologic findings, in every instance an increase in bone density, with or without radiolucent mottling, was demonstrated in the roentgenograms in some or nearly all segments of the skeleton.

5. In none of the cases was there any underlying condition found to account for the presence of the pathologic changes seen, *i.e.*, tuberculosis, metastatic cancer, history of myelotoxic agents, etc.

1. Most patients showed anemia of varying degrees of severity. In the peripheral blood there were nucleated red cells,

TABLE I: TWENTY CASES OF AGNOGENIC MYELOID METAPLASIA (Continued)

No.	Age and Sex	Size of Liver	Size of Spleen	Blood Picture	Sites of Bone Involvement	Types of Bone Involvement	Special Features of Involvement	Course	Proof
14	64 F W	Moderately enlarged	Markedly enlarged	Moderate anemia Normal WBC Characteristic smear	Both humeral shafts, upper femoral shafts, tibiae, and fibulae	Mild increase in bone density obscuring medullary cavities of involved bones. (Reported by previous observers. Films not re-viewed)	None	Living	Biopsy: myelofibrosis and osteosclerosis
15	45 F A. B.	Moderately enlarged	Markedly enlarged	Mild anemia Normal WBC and platelets Characteristic smear	Only films of chest available, including thoracic cage, clavicles, and shoulder girdles	Diffuse increase in bone density involving chest and associated structures	None	Living	Sternal puncture: myelofibrosis
16	41 F B. P.	Moderately enlarged	Moderately enlarged	Moderate anemia and mild leukocytosis Characteristic smear	Humeral shafts, pelvis, dorsal and lumbar spine, thoracic cage, and shoulders	Mild but diffuse overall increase in bone density, most marked in femoral shafts	None	Living	Biopsy of iliac crest: myelofibrosis and osteosclerosis
17	62 M M. R.	Moderately enlarged	Markedly enlarged	Moderate anemia WBC up to 166,000 Normal platelets Characteristic smear	Femoral and humeral shafts, leg bones, pelvic girdle, dorsal and lumbar spine, shoulders, and skull	Slight to moderate diffuse increase in bone density. Cor-tices, femoral shafts considered ably thickened	Alkaline phosphatase of white blood cells increased, excluding leukemia	Living	Bone marrow biopsy: myelofibrosis and osteosclerosis
18	64 M S. M.	Mildly enlarged	Mildly enlarged	Marked anemia Normal WBC Characteristic smear	Thoracic cage, shoulders, and dorsal spine	Mild increase in bone density with radiolucent zones	Polycythemia vera in 1942 treated with radioactive phosphorus Chronic myelogenous leukemia	Died. Autopsy	Myelofibrosis, osteosclerosis, and probably Hodg-kin's disease
19	70 F M. M.	Moderately enlarged	Slightly enlarged	Marked anemia Normal WBC and thrombocytopenia Characteristic blood smear—nucleated red cells with a shift to left in white cells down to the myelocytic series or younger	Entire spine, pelvis, femoral and humeral shafts, and thoracic cage	Generalized increase in bone density throughout	None	Living	Bone marrow biopsy: myelofibrosis
20	72 M R. P.	Moderately enlarged	Markedly enlarged	Severe anemia Normal white count Thrombocytopenia Nucleated RBC Nonmature WBC	Thoracic cage, shoulder girdles, dorsal and lumbar spine, pelvis, femoral and humeral shafts	Diffuse overall increase in bone density	Very large spleen	Living	Biopsy of iliac crest: myelofibrosis and osteosclerosis

6. Staining of the leukocytes for alkaline phosphatase showed a high level, in contrast to the findings in myelogenous leukemia, where the leukocyte alkaline phosphatase is abnormally depressed (9).

The age range in the series was from forty-one to seventy-two years, half the patients being seen in the sixth decade. All patients were white (our hospital population is predominantly white). The sex distribution was even (10 females and 10 males). With but few exceptions, hepatosplenomegaly was either moderate or marked. Anemia was found in 18 of the 20 cases, generally normochromic and normocytic in type. A leukocytosis was present in varying degree in 8 of the 20 patients; in Case 17 the white count reached 166,000. A significant leukopenia was seen in 2 cases. In most instances the platelet count was normal, but in Cases 1, 10, 13, 19, and 20, a significant thrombocytopenia was found. The platelets were increased in Cases 3, 8, and 11. Of the 20 cases, 17 showed a characteristic peripheral blood smear, as described above.

#### ROENTGEN FINDINGS IN PRESENT SERIES

The thoracic cage, humeral shafts, and pelvic girdle were shown roentgenologically to be most frequently involved, while the femoral shafts, dorsal and lumbar spine, and shoulder girdles presented characteristic changes to only a slightly less extent. The skull was involved in 5 cases, a finding at variance with statements in the literature concerning the absence of skull changes.

Figures 1 through 5 represent characteristic alterations in various parts of the skeleton in 5 typical cases of agnogenic myeloid metaplasia. The appended legends are explanatory. Figure 6 is a photomicrograph from a bone biopsy in this disease (Case 12).

There were two general forms of bone involvement. The first was a diffuse overall increase in bone density, generally widespread and of varied extent and degree. This type of change was present in 10 cases. A second general category included those



Fig. 5. Case 4. Frontal plane view of the femoral shafts. This is an example of considerable periosteal new bone formation along the medial margin of each femoral shaft in the lower third, more marked on the left. Increase in bone density with radiolucent mottling is seen.

cases in which the increased bone density was associated with variegated zones of radiolucent mottling, sometimes interspersed with nodular and linear opacities. This finding also was seen in 10 patients. Periosteal new bone formation in the long bones was demonstrated in 3 cases: in the lower ends of the femoral shafts in Case 4 (Fig. 5); in the femoral shafts, tibiae, and fibulae in Case 5 (Fig. 2, B); in the femoral and humeral shafts in Case 7. In 2 cases there was an increase in the density of the pedicles of the spine, involving the left pedicle of L-2 in Case 2 and three sites in the upper lumbar spine in Case 4. A radiolucent zone in the left iliac bone, which simulated osteoporosis circumscripta, was also noted in Case 2. We felt that this area was due to myelofibrosis, since no evidence of Paget's disease was observed elsewhere in the skeletal system.

The high frequency of involvement of the bones of the thoracic cage is of interest. With this observation in mind, the radiol-

ogist may suggest the diagnosis of agnogenic myeloid metaplasia on viewing a chest film.

#### DIFFERENTIAL DIAGNOSIS

Such diseases as osteopetrosis, metastatic cancer of the skeleton originating in the prostate or breast, fluorosis, congenital hemolytic anemias, phosphorus poisoning, etc., may at times be confusing roentgeno-

splenectomy may be palliative, but this procedure is generally contraindicated. Myleran has been used in a few cases recently but it is too early to evaluate its effects. No other specific treatment is known.

#### SUMMARY AND CONCLUSIONS

A series of 20 cases of agnogenic myeloid metaplasia has been presented with a tabu-

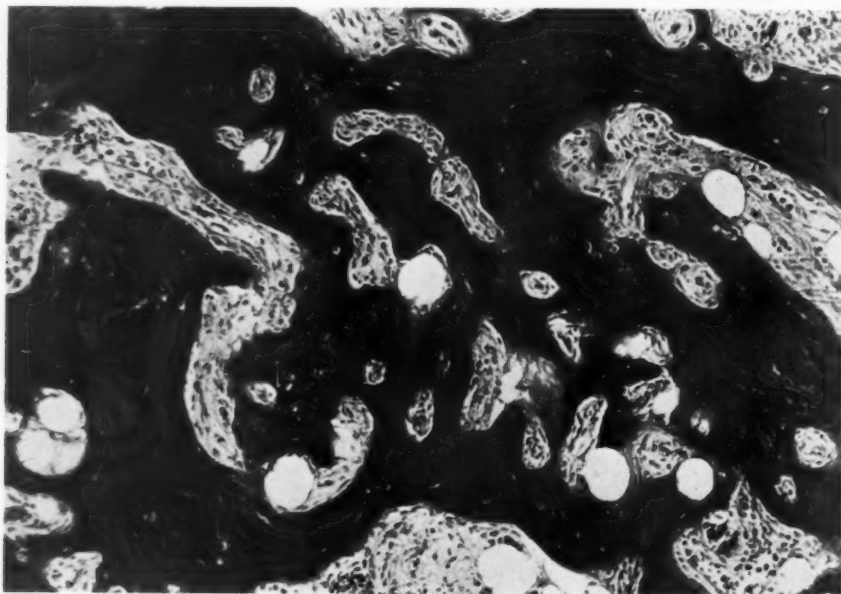


Fig. 6. Photomicrograph of a bone biopsy, showing increased density of the bone trabeculae and replacement of active marrow by fibrous connective tissue.  $\times 140$ .

logically. However, the characteristic blood picture in a middle-aged or older adult, with hepatosplenomegaly and/or other evidences of extramedullary hematopoiesis, together with typical bone changes such as a diffuse increase in density with or without variegated zones of radiolucent mottling in the dorsal and lumbar spines, pelvis, femoral and humeral shafts, and thoracic cage, make the entity easily recognizable.

#### TREATMENT

Treatment is supportive, consisting of blood transfusions and other measures as indicated. In certain selected patients

lar summary and evaluation of the clinical findings, the blood picture, and the sites and types of bone involvement. The roentgen features of the skeletal changes have been discussed in detail. The specificity of this clinical-hematologic-roentgenologic entity has been emphasized, and the diagnostic features recorded.

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## SUMMARIO IN INTERLINGUA

**Agnogenic Metaplasia Myeloide**

Agnogenic metaplasia myeloide es un disordine in que hematopoiese occurre extra le usual situs in le medulla e que es le plus frequentemente accompagnate de fibrosis del medulla. Le condition representa un distincte entitate clinico-hematologico-roentgenologic con particularitates characteristic. Es tabulate le constataciones in 20 casos, con evaluation del tractos clinic, del tableau del sanguine, e del situs e typos de affection ossee.

Le distribution secundo le etate del patients esseva inter 41 e 72 annos, con un medietate del casos in le sexte decennio del vita. In le majoritate del casos il habeva anemia plus o minus sever, e in omne casos, con un exception, hepatosplenomegalia esseva presente. Alterationes ossee esseva trovate in omnes.

Le roentgenogrammas monstrava que le

thorace, le diaphyses humeral, e le cintura pelvica esseva afficite le plus frequentemente, durante que le diaphyse femoral, le columna vertebral dorsal e lumbar, e le cintura spatular monstrava alterationes characteristic a un grado solo levemente minus frequente. Le cranio esseva afficite in 5 casos —un constatacion que contradice le assertiones in le litteratura concernente le absentia de alterationes cranial. Il habeva duo typos general de affection ossee: (1) un diffuse augmento generalisate in le densitate ossee—generalmente multo diffundite e variate in grado e extension—e (2) un augmento in le densitate del ossos con zonas variegate de radioluciente maculation, interspergite a vices de opacitates nodular e linear. Il habeva un alte frequentia de affectiones del ossos thoracic.

Le tractamento es supportative.





## Comparison of the Use of Standard Depth Dose Data at 250 Kvp and 2 Mev by Direct Measurement of Tumor Exposure Dose in Vivo<sup>1</sup>

PETER WOOTTON, B.Sc., and SIMEON T. CANTRIL, M.D.

IT IS WELL known that conventional depth-dose tables represent the distribution of exposure dose along the central axis of an x-ray beam in a homogeneous, unit density phantom of effectively infinite dimensions. Clinical material is rarely represented by this model and therefore the data thus obtained will be subject to corrections in many clinical situations.

Corrections may be obtained by two different paths. One approach is to investigate the effect of limitations of dimension on depth-dose data by reducing the size of the phantom. Data obtained by this method have been described in the literature (1, 2). Such corrections are relatively easy to apply, but further corrections for inhomogeneities, such as bone, presuppose an accurate knowledge of the thickness, extent, degree of calcification, etc., of the interfering structure (3). Such information is rarely available.

Another approach has been to measure tumor exposure dose in a number of standardized situations *in vivo* or in cadavers (4, 5, 6), comparing the data thus obtained with conventional tables. Factors may then be obtained which permit tumor doses to be computed from standard depth-dose tables for reproductions of these standardized situations. Earlier work with this approach showed a small discrepancy between measurements *in vivo* and in cadavers. Also, much of the work was limited, in the deep therapy range, to 200 kvp and, in the supervoltage range, to 700 kvp.

It was desired to extend this type of approach, encompassing corrections for limitations in size and inhomogeneities in one factor, by *in vivo* measurements in

the 250-kvp range in deep therapy and 2 Mev in the supervoltage range. For this purpose an ionization-chamber dose-rate meter instrumentation was chosen, in preference to condenser chambers, as it would permit gross errors of alignment to be promptly observed and adjusted, and measurements so made would not interfere with the normal treatment pattern of the patient.

The dose-rate meter circuit was patterned after that of Fedoruk (7). This circuit was chosen because of its known characteristics of linearity, stability, portability, ease of maintenance, and lack of drift with short warm-up time. The ionization chamber was designed with the following requirements in mind:

1. The chamber and its connecting flexible cable should be of small enough dimensions to permit insertion into sites such as the esophagus, nasopharynx, male bladder, etc., *in vivo*, under local anesthesia at the most, and with minimal trauma.
2. The flexible cable should not give rise to spurious signals.
3. The chamber tip should be waterproof and suitable for cold sterilization.
4. The chamber should be mechanically robust and unlikely to shed components in use.
5. The chamber volume should not be subject to changes due to flexion of the cable.
6. The chamber should have the following radiation characteristics: (a) It should yield essentially the same depth dose data in an infinite unit-density medium at the energies under study as given in standard tables (8, 9). (b) It should exhibit little shadow due to the

<sup>1</sup> From the Tumor Institute of the Swedish Hospital, Seattle, Wash. Research assisted by grants from Damon Runyon Cancer Research Fund and U. S. Public Health Service. Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16-21, 1958.

copper mesh shield in the connecting cable.

The external diameter of the chamber was 4.72 mm. and of the cable 4.8 mm. The cable was of the RG 58U type, rendered nonmicrophonic by withdrawal of the central wire and insulation from the shield and external sheath, coating of the surface of the insulator with graphite, and reinsertion in the shield and external sheath. The chamber was originally constructed with polystyrene insulation. It was found to be very difficult, however, to avoid the formation of cracks during machining, leading to serious leakage problems at these dimensions (10). The use

The chambers were dipped in molten ceresin wax and kept so coated at all times. Storage in a desiccator between uses reduced leakage problems to a minimum.

The chambers were found to yield depth-dose data in a water phantom within 3 per cent of standard data, after correction for cable leakage, up to a field size of  $16 \times 16$  cm. and 10 cm. deep for radiation generated at 250 kvp having a half-value layer of 2 mm. Cu. However, the ratio of measurements *in vivo* to those in a phantom have been expressed as the ratio for the same chamber in the given situation.

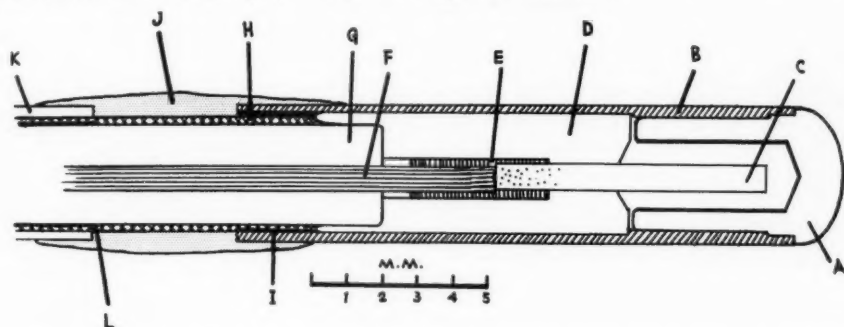


Fig. 1. Diagram of the ionization chamber used in measuring tumor dose *in vivo*. A. Bakelite cap and liner, graphite-coated. B. Aluminum shell. C. Carbon central electrode. D. Polyethylene insulator. E. Brass connector. F. Copper core of RG 58U cable. G. Polyethylene core of RG 58U cable, graphite-coated. H. Copper braid screen of RG 58U cable. I. A-I type cement. J. Black weather strip cement. K. Outer sheath of RG 58U cable. L. Graphite coating to polyethylene core.

of a guard ring construction was not considered feasible if the dimensions were to be kept small. A change was therefore made to polyethylene for insulation. This material does not lend itself to very elaborate machining and the chamber, therefore, was designed to reduce this to a minimum (Fig. 1).

Connection between the electrometer tube and the flexible cable was by means of a coaxial connector, utilizing the central conductor of the cable as the male portion of the plug. This allowed the inner conductor and insulator to move relative to the sheath up to the moment the cable was attached to the electrometer and screwed home, thus retaining its flexibility and reducing strain on the connections at the ionization chamber end.

Leakage in the cable under irradiation was found to be proportional to the cable length irradiated, a signal equal to 5 per cent of that from the ionization chamber being generated by 10 cm. of irradiated stem. This represents the leakage in a  $20 \times 20$ -cm. field, which is rarely used in clinical practice. The chambers were therefore considered satisfactory for the purpose in hand.

#### ALIGNMENT OF TUMOR SITE AND CHAMBER

In all patients the tumor site was located by conventional radiography and markers were placed on the skin. The treatment fields were then located and checked under fluoroscopy, and the chamber was inserted so that the center of the sensitive volume coincided with the cen-

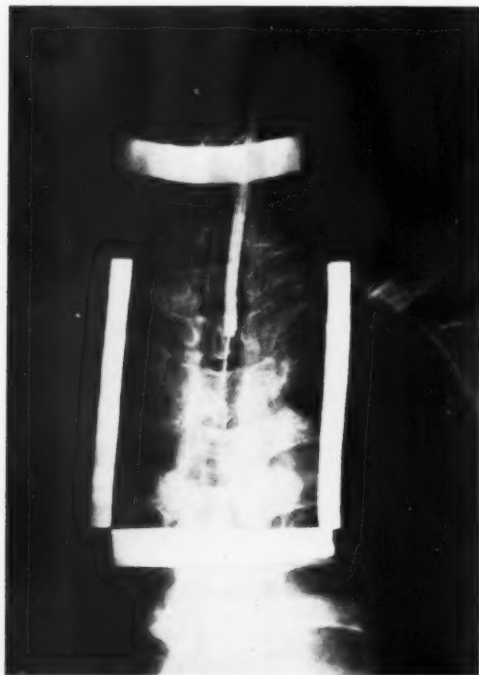


Fig. 2. Radiograph obtained with a diagnostic unit, showing the position of the ionization chamber relative to the treatment field in an esophagus.

ter of the treatment field as determined by inspection under the fluoroscope. To check the possibility of movement of the chamber or of misalignment due to differences in angulation between the fluoroscopic beam and the 2-Mev beam, the chamber was connected to the electrometer and the readings of exposure dose made for successively smaller fields. A sudden drop in the reading allowed an estimate to be made of the eccentricity of the chamber relative to the field. In some cases port films were taken with the chamber in position if there was any discrepancy between the centralization under fluoroscopy and the successively smaller field method (Figs. 2 and 3). Depth of the chamber was estimated from lateral radiographs, outlines of the patient, or direct measurement.

The patient was set up as for treatment at 2 Mev and tumor exposure dose was noted. The treatment table was then

wheeled into the 250-kvp room, without change in the patient's position, and the field was reproduced by the skin marks and the tumor exposure dose was again noted. With the patient's comfort and welfare in mind, measurements were made under both conditions and for all treatment fields on the same day, as far as was clinically feasible. The results of the study are grouped according to anatomical site of the disease.

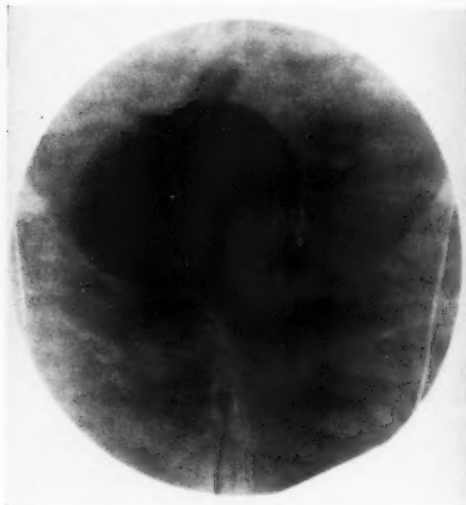


Fig. 3. A 2-Mev port film showing the position of the ionization chamber relative to the treatment field. Bladder air-filled.

#### RESULTS

1. *Carcinoma of the Esophagus:* The fields normally used in the Tumor Institute are parallel opposing fields approximately  $8 \times 15$  cm., with the long axis parallel to the esophagus (Figs. 4A and 5).

The anteroposterior diameter of patients studied ranged from 18.5 to 23 cm., the depth of the chamber from the skin from 7.5 to 12.5 cm. The ratios of the *in vivo* to phantom measurement are given in Table I, as measured in 10 patients at 2 Mev and 5 patients at 250 kvp.

In one patient the technic was changed on the 2-Mev machine by replacement of the posterior field with two posterior obliques, angled at  $45^\circ$  and traversing lung.

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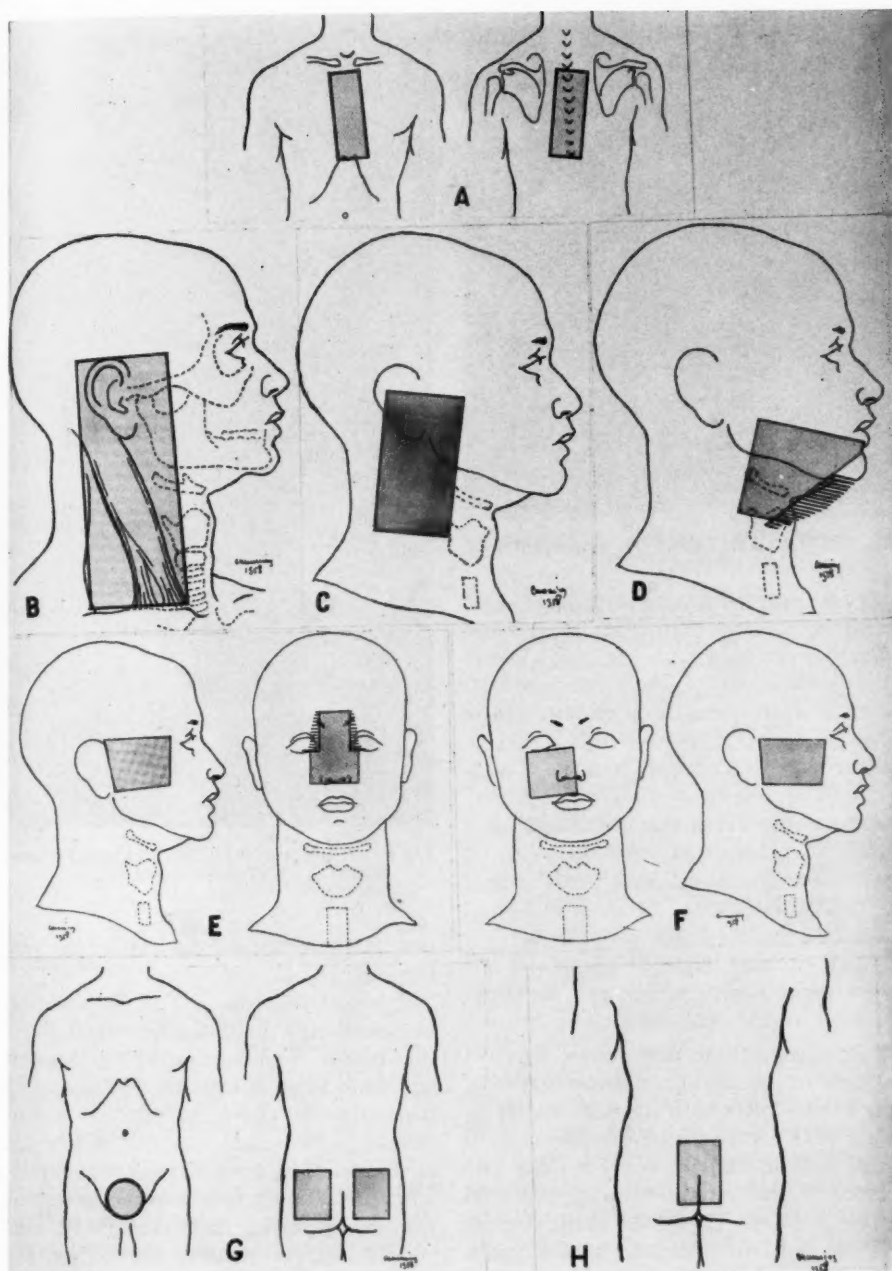


Fig. 4. Location of fields. A. For esophagus. B. For nasopharynx. C. For tonsillar fossa. D. For tongue and floor of mouth. E. For ethmoids. F. For maxillary sinus. G. For bladder (posterior fields approximately 45° oblique). H. For rectum.



Fig. 5. A 2-Mev port film of an esophageal field.

TABLE I: RESULTS OBTAINED IN ESOPHAGUS

	2 Mev 12.5 mm. Cu. h.v.l.	250 kvp 2 mm. Cu. h.v.l.
Range of field sizes	7 × 11 to 16 × 16 cm.	7 × 11 to 20 × 20 cm.
Depth of chamber	7.5 to 12.5 cm.	7.5 to 12 cm.
Anteroposterior diameter of patients	18.5 to 23 cm.	18.5 to 22 cm.
No. of patients	10	5
Ratio of <i>in vivo</i> to phantom measurement		
Anteroposterior fields	1.02	0.93
Postero-anterior fields	0.99	0.81

The tumor exposure dose then rose to 66 per cent of the skin dose compared with 53 per cent expected from tables. It is assumed that for clinical purposes corrections of less than 5 per cent are not warranted. The data on esophagus would therefore indicate that, for clinical purposes, the data in standard tables fairly represent the exposure dose in parallel opposing fields as used in the esophagus for 2 Mev. The exposure dose at 250 kvp is subject to a 7 per cent correction for anteroposterior fields and 19 per cent for postero-anterior fields, while the dose with 2 Mev may be increased by 25 per

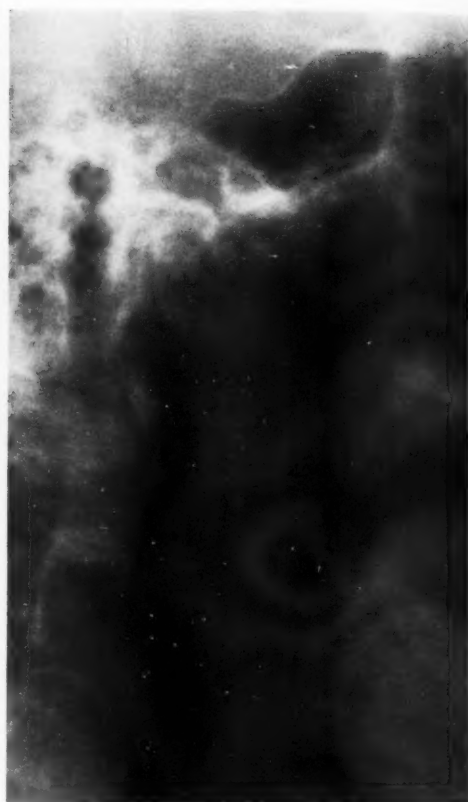


Fig. 6. A 2-Mev port film of fields used for treatment of nasopharynx.

cent if there are air cavities in the path of the beam.

2. *Nasopharynx:* The chamber was introduced into the nasopharynx, under local anesthesia, by insertion along the floor of the nasal fossa with both digital and visual inspection to check its position. Further checks were made by the reducing-field method and by port films in cases of doubt. The method of treatment was again by parallel opposing fields (Figs. 4B and 6). As for the esophagus, the patients were transferred to 250 kvp and the fields reproduced by the skin marks and the tumor exposure dose again measured. The depth of the chamber was measured as accurately as possible from the center of the treatment field.

The results for 5 patients on both the



TABLE II. RESULTS OBTAINED IN NASOPHARYNX

	2 Mev 12.5 mm. Cu h.v.l.	250 kvp 2 mm. Cu h.v.l.
Range of field sizes	8 × 8 to 6 × 12 cm.	8 × 8 to 6 × 12 cm.
Depth of chamber	5 to 7 cm.	5 to 7 cm.
No. of patients	5	5
Ratio of <i>in vivo</i> to phantom measurement	1.00	0.78

2-Mev and the 250-kvp unit are shown in Table II. Field sizes ranged from 6 × 12 cm. to 8 × 8 cm., and chamber depths from 5 to 7 cm. measured from the center of the treatment field. Within the limits set before, the data in standard tables would appear to represent the tumor exposure dose for 2-Mev x-rays. Data in standard tables, when applied to these fields at 250 kvp, would appear to be subject to a 22 per cent correction.

3. *Ethmoids*: Patients with ethmoid lesions were treated with fields in a common plane but mutually perpendicular, one or two lateral fields and an anteroposterior (Fig. 4E), the size of the lateral field being reduced from the anterior edge as

TABLE III. RESULTS OBTAINED IN ETHMOIDS

	2 Mev 12.5 mm. Cu h.v.l.	250 kvp 2 mm. Cu h.v.l.
Range of field sizes	5.5 × 7 to 10 × 10 cm.	5.5 × 7 to 10 × 10 cm.
Depth of chamber	7 to 9 cm.	7 to 9 cm.
No. of patients	3	3
Ratio of <i>in vivo</i> to phantom measurement		
Anterior	1.03	0.951
Lateral	0.98	0.77

treatment progressed. The progressive reduction in width of the lateral field by gradual recession from the anterior margin avoids the build-up of excessive dose at the lateral margin of the maxilla and orbit. The chamber is inserted along the floor of the nasal fossa to a depth such that the tip of the chamber can be felt, and seen by mirror, to be just within the posterior nasal fossa. This region represents the posterior medial limit of the zone in which

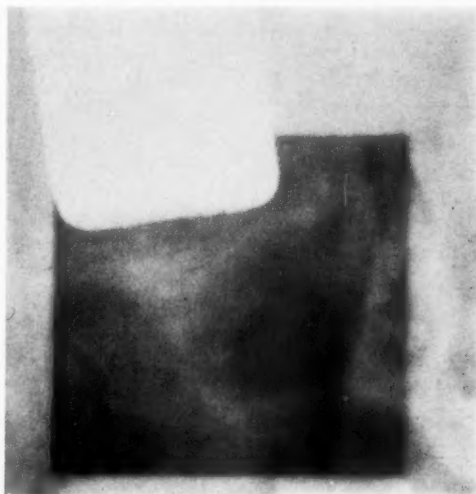


Fig. 7. A 2-Mev port film of anteroposterior field for treatment of maxillary sinus.

dose can be measured but, by contour plotting of dose distribution for the individual patient, an attempt is made to equalize the dose throughout the nasal fossae, ethmoids, and maxillary sinus. The exposure dose for these patients by way of lateral and anteroposterior fields at 250 kvp and 2 Mev was measured. The field sizes ranged from 5.5 × 7 to 10 × 10 cm. and the distance between the center of the field and the chamber ranged from 7 to 9 cm. for lateral fields and 7 to 7.5 cm. for anterior fields (Table III).

The results indicate that no correction factor is required at 2 Mev or at 250 kvp for anterior fields but that a correction factor of 23 per cent is necessary for lateral fields at 250 kvp.

The traverse of the air spaces of nasal fossae and ethmoids by the beam from the anterior field accounts for the correspondence of measured and calculated dose contribution for 2 Mev and 250 kvp.

4. *Maxillary Sinus*: The maxillary sinus site is again treated with two parallel opposing or mutually perpendicular fields (Figs. 4F and 7). The placement of the chamber is anatomically similar to that for the ethmoidal study. The anterior field for maxillary sinus is seen to differ from that used in ethmoidal cancer, but

TABLE IV: RESULTS OBTAINED IN MAXILLARY SINUS

	2 Mev 12.5 mm. Cu h.v.l.	250 kvp 2 mm. Cu h.v.l.
Range of field sizes	5.5 × 7 to 10 × 10 cm.	5.5 × 7 to 10 × 10 cm.
Depth of chamber	3 to 9 cm.	3 to 9 cm.
No. of patients	6	6
Ratio of <i>in vivo</i> to phantom measurement		
Lateral	1.03	0.78
Anterior	1.00	0.85

the problem of overirradiation at the junction of anterior and lateral fields is treated similarly. A total of 6 patients were investigated with field sizes ranging from 5.5 × 7 to 10 × 10 cm. and chamber depths of 3 to 9 cm. for anterior fields, 5.5 × 7 to 10 × 10 cm. and 4 to 8 cm. chamber depth for lateral fields. The results are summarized in Table IV.

Again no correction factor is required at 2 Mev. A 22 per cent correction is necessary for the lateral fields and a 15 per cent correction for the anteroposterior fields at 250 kvp.

5. *Tonsillar Fossa*: Parallel opposing fields or a single field may be used in the tonsillar fossa (Fig. 4C), ranging from 6 × 8 to 8 × 14 cm., with chamber depths of

TABLE V: RESULTS OBTAINED IN TONSILLAR FOSSA

	2 Mev 12.5 mm. Cu h.v.l.	250 kvp 2 mm. Cu h.v.l.
Range of field sizes	7 × 9 to 8 × 14 cm.	6 × 8 to 8 × 14 cm.
Depth of chamber	5 to 7.5 cm.	5 to 7 cm.
No. of patients	4	2
Ratio of <i>in vivo</i> to phantom measurement	0.98	0.97 (no mandible) 0.87 (behind mandible)

5 to 7.5 cm. A total of 4 patients were investigated on the 2 Mev-unit and 2 on the 250-kvp unit. The results, summarized in Table V, indicate that, while the exposure dose measured by chamber is lower than that in the depth-dose tables, probably due to limitations of phantom size, this effect is small. The discrepancy in the two measurements with 250 kvp represents the interposition of mandible as a factor in lowering the measured dose.

6. *Bladder*: Disease in the bladder is treated through three fields (Figs. 4G, 8, 9). One anterior circular suprapubic and two bilateral oblique ischiosacral fields are used. The fields are localized by introduction of air into the bladder and radiography with 2-Mev x-rays. The angulation of the beam is then noted for daily reproduc-

TABLE VI: RESULTS OBTAINED IN BLADDER

	2 Mev 12.5 mm. Cu h.v.l.	250 kvp 2 mm. Cu h.v.l.
Range of field sizes	9 cm. diam. to 10 × 10 cm.	9 cm. diam. to 9 × 9 cm.
Depth of chamber	6.5 to 15 cm.	6.5 to 15 cm.
No. of patients	4	1
Ratio of <i>in vivo</i> to phantom measurement	1.00	0.99

tion of the fields marked on skin. The insertion of the chamber into the male bladder, following local urethral and vesical anesthesia, requires careful manipulation and we have found the cooperation of our urologic colleagues most helpful.

Measurements were made on 5 patients at 2 Mev and 1 at 250 kvp. Field sizes ranged from circular anterior fields of 9 cm. diameter to posterior angled fields 10 × 10 cm., with field-to-chamber distances of 6.5 to 15 cm. Since the bladder is relatively voluminous and positioning errors are therefore possible, and the fields are designed to yield uniform exposure over a volume to include the bladder, the results are expressed as the ratio of the chamber measurements *in vivo* in this volume to those expected from phantom measurements from all three fields combined (Table VI). It can be seen that at neither energy are correction factors necessary for this arrangement of fields.

7. *Tongue and Floor of Mouth*: Two fields in parallel opposition or a single field have been used in the oral cavity (Fig. 4D). The chamber was placed at the site of the lesion and the distance to center of field measured directly. Two patients were investigated at 2 Mev and 1 at 250 kvp. Field sizes ranged from 7 × 8 to 9 × 7 cm., and depths from 3 to 7.5 cm. (Table VII).

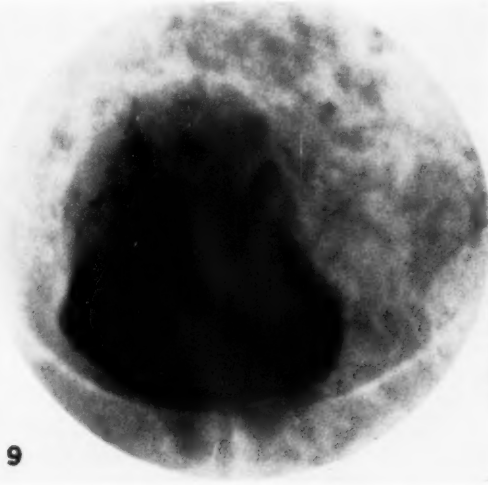


Fig. 8. A 2-Mev port film showing posterior oblique field for treatment of bladder. Bladder air-filled.

Fig. 9. A 2-Mev port film showing anterior field used in treatment of bladder. Bladder air-filled.

TABLE VII: RESULTS OBTAINED IN TONGUE AND FLOOR OF MOUTH

	2 Mev 12.5 mm. Cu h.v.l.	250 kvp 2 mm. Cu h.v.l.
Range of field sizes	9 × 7 to 7 × 8 cm.	7 × 8 cm.
Depth of chamber	3 to 7.5 cm.	5.75 cm.
No. of patients	2	1
Ratio of <i>in vivo</i> to phantom measurement	0.94	0.89

It can be seen that tumor exposure dose at 2 Mev is about 6 per cent low, probably due to limitations of size of scattering medium. The exposure dose at 250 kvp was 11 per cent lower than the standard table indicates. This represented interposition of the mandible.

8. *Rectum*: Rectal cancer is treated with a single posterior field (Fig. 4H). The dosage received was investigated in 1 patient on both the 2 Mev and 250 kvp machines. The field size was 8 × 12

cm. and the depth of the chamber 8 cm. from the skin (Table VIII). No correction was necessary at 2 Mev, but the exposure dose at 250 kvp was only 78 per cent of the value in a water phantom, due to interposed bone.

It may be seen from this range of sites of clinical interest to the radiotherapist, treated through commonly accepted fields, that the presence of air cavities, bone, and smaller masses of absorbing media than were used in obtaining standard depth-dose tables, lead to errors in estimating tumor exposure doses. For 2-Mev radiation these errors are large only if air cavities in the beam are ignored, while errors up to 25 per cent are common in fields treated by 250-kvp radiation traversing bone. Smaller errors may be expected due to limitations in absorber size. The use of the chamber also serves at times to deflate sharply the therapist's confidence in his ability to place the field correctly by clinical examination alone.

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TABLE VIII: RESULTS OBTAINED IN RECTUM

	2 Mev 12.5 mm. Cu h.v.l.	250 kvp 2 mm. Cu h.v.l.
Field size	8 × 12 cm.	8 × 12 cm.
Depth of chamber	8 cm.	8 cm.
No. of patients	1	1
Ratio of <i>in vivo</i> to phantom measurement	1	0.78

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#### SUMMARIO IN INTERLINGUA

##### **Evaluation Del Datos Standard Pro Le Dosage De Profundor A 250 KVP E 2 MEV Per Le Directe Mesuration In Vivo Del Dosages De Exposition Tumoric**

Tabulas clinic de dosage de profundor representa le distribution de dosage de exposition al longo del axe central de un fasce de radios X in un phantoma de homogenee densitate de dimensiones effectivemente infinite. Proque isto raramente representa exactemente le materia clinic, le datos assi obtenite require correctiones in multe situationes clinic.

Pro obtener appropriate factores de correction, mesurationes esseva facite in patients sub tractamento e le proportion inter le mesurationes obtenite in vivo e le mesurationes in phantasmas esseva deter-

minate. Le modos de tractamento investigate esseva 2 Mev (spissitate de medie valor 12,5 mm de cupro) e 250 kv (spissitate de medie valor 2 mm de cupro). Factores de correction esseva obtenite pro le sequente sitios; esophago, nasopharynge, sinuses ethmoide e maxillar, fossa tonsillar, vesica, lingua e solo del bucca, e recto.

Le mesurationes in vivo esseva facite per medio de un camera de ionisation que esseva montate super un cable flexible e que habeva dimensiones satis micre pro permitir su insertion in le sitios sub investigation.



# An Approach to Biplane Cineangiocardiology

## 1. Background and Objectives<sup>1</sup>

HERBERT L. ABRAMS, M.D.

DEVELOPMENTS IN angiocardiology during the two decades since Castellanos and his co-workers (7) and Robb and Steinberg (31) independently reported its application to man have been numerous and far-reaching (2, 34). Each addition to the technic has been aimed at improving its efficacy as a diagnostic method or as an investigative tool and at augmenting the range and quality of the information to be gained from a single study.

The attractiveness of applying the cine method to angiocardiology has long been evident, but the limitations have been too serious to encourage widespread use until recent years. These limitations, namely, poor detail and relatively high radiation exposure, have not, however, prevented a thorough and careful investigation of cineradiologic technics. As early as 1896, MacIntyre undertook studies in roentgen cinematography (24). Thereafter, there were sporadic efforts to utilize the method (9, 15, 17, 23) until the thirties, when Reynolds (30), Janker (19), Barclay (4), Stewart (36), and others (6, 12) restudied its application to a number of problems. The decade that followed witnessed continued activity on the part of Janker and his co-workers, organization of an active cine program at the University of Rochester, and a number of significant technical developments (29, 30, 37).

In all conventional cinerontgen studies, the problem of obtaining adequate light without excessive radiation exposure to the patient has been a considerable one. Because of its promise in attacking precisely this problem, the introduction of practical image intensification provoked a resurgence of interest in cinefluorography. Utilizing the 5-inch image intensifier, some

groups have successfully studied cardiovascular anomalies in infants and children (21, 35).

In reviewing our experience with conventional angiocardiology some years ago (2), it was apparent that the diagnostic effectiveness of such an approach had been adequately appraised and securely established. As a means of delineating morphology *in vivo*, it was extraordinarily useful and an integral part of the armamentarium for diagnosis of heart disease. As a method of physiologic study, it had proved limited. It seemed likely that a more flexible unit might be of significant help in widening the applications of the technic. With this in mind, a descriptive analysis of the attributes and objectives of such an installation was undertaken.

1. *The Study of Motion and the Filming Rate:* The major advantage of fluoroscopy over roentgenography is that it permits the study of motion. The pulsation of the heart and aorta can be analyzed visually, and the pulmonary vessels can be studied during different phases of the cardiac cycle. A disadvantage of conventional fluoroscopy is its failure to yield a permanent record for systematic study. This virtually excludes its application as such to angiocardiology, for the passage of the opaque medium is too rapid, and events too fleeting, to be followed with certainty by the fluoroscopist. Motion-picture photography of the fluoroscopic screen during angiocardiology provides a permanent recording of cardiac movement—both external and internal—available for study and restudy. Details of anatomy which may be difficult to distinguish in a single frame become visible when the film is studied as a sequence.

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The first angiocardiographic studies performed by Castellanos and his co-workers employed a single film (7), exposed when the opaque medium was thought to be in the right cardiac chambers. Robb and Steinberg, utilizing ether and decholin circulation times to gauge the proper moment of exposure, succeeded in obtaining both dextro- and levoangiocardigrams (31). It became obvious that a single film or a two-film study might not only be uninformative but actually misleading. In an effort to satisfy the need for multiple film studies, high-speed cassette changers, roll film and cut film magazine cameras, and cinefluorographic assemblies were developed. Within recent years, dependable roll film and cut film units yielding six to ten films per second have been made commercially available.

From a practical point of view, the diagnosis of most common cyanotic anomalies in infancy and childhood can be accomplished with relatively few exposures per unit time. On the other hand, the detection of small shunts and the analysis of the exact moment in the cardiac cycle when dynamic changes occur is facilitated by high exposure rates. This is particularly true of clinical studies in the presence of a rapid heart rate, when multiple exposures during a number of cardiac cycles permit more precise evaluation of the consistency of findings. The construction of atrial and ventricular volume curves in an effort to elucidate the dynamics of mitral valvular disease (or to study cardiac function under altered physiologic conditions) can be done most accurately when many points in the cardiac cycle are recorded (10).

Thus, the virtue of the cine approach lies not only in its exact duplication of the dynamic changes of the heart and great vessels, as they occur, but also in its ability to provide a very rapid exposure rate with multiple frames for individual analysis.

2. *Biplane Recording:* Single plane studies present the problem of overlap of the cardiac chambers following opacifica-

tion. Thus, a right-to-left shunt at the atrial level may be clearly apparent in one projection, but in the same projection the outflow tract of the right ventricle and pulmonary valve may be obscured. With single plane equipment, it is possible to obtain two sequential studies at right angles to each other; but this is done at the risk of increasing the hazard to the patient, and without simultaneity of exposure.

The need for biplane projections to obviate the problem of chamber overlap was recognized early (8) but was not actually applied to rapid film changers until the middle and late forties. The rapid cassette changer developed by Axén and Lind was employed for biplane work in 1946 (3), and the roll film cameras were readily adaptable to coupling for biplane studies. Concurrent biplane cineangiography was not explored in the forties, although a stereoscopic cinefluorographic approach was described (33, 37). Finally, Chapman, employing the type of cinefluorographic unit developed at the University of Rochester by Weinberg *et al.*, coupled two such units for biplane study (10). In this installation, the movie cameras photograph conventional fluoroscopic screens, and thus require relatively high radiation exposures. Furthermore, the capacity of the equipment is taxed when thick patients are studied. The unit is admirably suited to experimental studies in the dog, and to some clinical studies.

The advantages of simultaneous study in right-angled planes seemed sufficiently great to warrant inclusion of biplane facilities in an optimal cineangiographic unit.

If biplane studies are to be employed, it is essential that the two runs be synchronized. Although the exposures may be in phase or out of phase, it is thus possible to delineate with precision their time relationship to each other.

3. *Exposure Times:* As the need to delineate the finer details of intracardiac anatomy became more urgent with the burgeoning of cardiac surgery, the desirability of short exposure times in the milli-

second range was stressed. High energy generators, capable of exposure times of  $1/120$  of a second, were developed and applied to angiocardiology. Within recent years the usefulness of an electronic switching system has been explored (13), and studies have been performed with exposures as short as one-half millisecond. Such exposure times should theoretically permit stopping of "cardiac motion," and a consequent diminution of motion blurring. Yet the importance of ultra-short exposures in cine work should be most apparent in individual frame analysis, rather than in the study of the continuous strip. In order to assess their usefulness, it was determined that the final installation should be capable of such short exposure times.

4. *The Total Time of the Angiocardio-graphic Study:* In the analysis of our case material, it was apparent that a total elapsed time of five seconds was perfectly adequate for most angiocardio-graphic studies of the cyanotic anomalies seen in infancy and childhood. In the study of acquired disease, and particularly in the elucidation of the dynamics of the left cardiac chambers in adults, total time sequences of ten, fifteen, and even twenty seconds may be required. Thus, in mitral stenosis, there may be considerable left atrial opacification twenty seconds after the injection. It seemed desirable, then, to assure a capacity for relatively long runs.

5. *The Relationship of the X-ray Exposure to the Events of the Cardiac Cycle:* As early as 1931, Janker and his co-workers recorded the electrocardiogram during cinerentgen studies (18). The need for such correlative study in angiocardiology was subsequently stressed by Axén and Lind, who described their own approach to the problem in 1950 (3). Certainly, the simplest method of relating anatomic change during angiocardiology to the electrical events of the heart cycle is the two-channel recorder on which electrocardiogram and exposure time are simultaneously noted. If the continuous intracardiac or carotid pressure tracing

can be added or substituted, additional information can be obtained. The important point is to be able to fix the precise moment when an exposure is made. In this way, it is possible to study the timing of maximal shunt in cardiac septal defects, or the behavior of the atria during ventricular systole in the presence of valvular disease. Ideally, the concurrent recording of the cineangiocardio-graph, right ventricular pressure, carotid pressure, electrocardiogram, and phonocardiogram offers an opportunity for multiphasic study and analysis of anatomic, physiologic, and electrical events occurring in the normal and abnormal heart. Hence, provision for a recording device was considered mandatory in the planning of the installation.

6. *The Method of Opacification:* The original angiocardio-graphic studies were based on the intravenous injection of an opaque medium. In many cases, the bolus thus injected remained sufficiently well opacified to demonstrate the congenital abnormalities being studied. In the presence of cardiac enlargement, however, the opaque medium became sufficiently diluted so that its roentgenographic image was no longer dense enough to allow definitive interpretation. Intracardiac or selective angiocardiology was undertaken as a response to the need to get a large bolus of the opaque medium in a particular area in a short time (11, 20). Not long thereafter, the problem of opacifying the left heart satisfactorily led to left ventricular puncture (22, 28) and subsequently left atrial puncture (5) as a means of injecting the medium directly into the left cardiac chambers.

In selective angiocardiology, the medium must necessarily be introduced through a catheter inserted into the heart through one of the great veins. Since the resistance offered by the catheter wall is of large magnitude, the development of high-pressure injection devices was required. In response to this need, both manual and remotely controlled automatic pressure injectors were devised. One of the advan-

tages of the automatic injector was that it could be utilized without exposure of personnel. Furthermore, the delivery of a controlled volume of fluid per unit time was desirable, and the maintenance of constant pressure was necessary for this. Such injectors as the Gidlund model (16), with adequate temperature control, represented a satisfactory prototype.

7. *Patient Irradiation:* The past few years have seen a renewed interest in the problems of protection from ionizing radiation, stimulated by the need to assess the hazards of nuclear explosions and by the increasing use of radioactive isotopes. The dangers of diagnostic roentgen studies have been exaggerated by many, and perhaps underestimated by some. There is general agreement that medical need is a sound justification for most diagnostic procedures, properly performed. Within this framework, every means of diminishing patient and personnel irradiation should be applied.

Direct cine recording from the conventional fluoroscopic screen involved sufficient patient irradiation to preclude its widespread application. Precise figures for dosage administered to large groups of patients during cineangiography are difficult to find, but dosages alluded to are usually 20 r or more to the surface of the chest (10, 29, 32). In considering simultaneous biplane studies, the factor of radiation dosage becomes obviously more important.

The development of image intensification (27) has made it possible to perform cinefluorographic studies at dosage levels significantly below those previously required. If the exposure can be synchronized with the camera shutter, and the patient irradiation occur only when the film is being exposed, a further reduction of dosage may be obtained. Additional factors that are essential for patient protection are flexible and effective collimating devices and adequate tube filtration.

8. *Field Size:* Conventional fluoroscopic screens vary in size from 8 x 10 to 12 x 16 inches. Almost never will the

expert fluoroscopist employ the entire screen for study, and most of the time a field size of 5 x 5 inches will be adequate for diagnostic purposes. Nevertheless, a large screen size is desirable if the unit is to be flexible and adaptable to adults as well as to infants and children. This is also true of cineangiography. Although a 5-inch intensifier may be useful for the study of the infant with congenital heart disease (35), a larger screen is desirable for complete study of the heart and great vessels in older children and adults. The development of an 11-inch image intensifier represented a significant step forward in this connection, and promised far greater versatility for a unit designed for biplane cardiovascular study.

9. *Patient Size:* Just as the field size may limit the application of cine studies, so the generator and tubes may do so if their capacity is limited. Although the integration of image intensification into a unit obviously augments its capacity to penetrate adult patients, the density required for satisfactory cineangiography is sufficiently great so that powerful generators and high capacity equipment must be included in the installation.

10. *Film Resolution:* Perhaps the most important barrier to widespread employment of cinefluorography has been the relatively poor definition of motion picture study. So great has been the contrast in detail between a single projected frame from a cine study and a single film from a properly performed conventional angiographic study that many in the field of cardiovascular radiology have hesitated to accept the cine method. The fine detail of the full-size roentgenogram will never be duplicated on 16- or 35-mm. film. Nevertheless, the development of faster lenses, more sensitive and fine grain film, superior processing solutions, and better projection apparatus and projection screens have helped to narrow the gap. Thirty-five-millimeter film is preferable to 16-mm. film in this respect, because the ratio of film grain size to image size is improved, resulting in better definition. In

cineangiographic studies, a further improvement in eliminating motion blurring may be obtained by utilizing exposures in the millisecond range.

11. *The Quantity of Opaque Medium:* Analyses of different angiographic series indicate that the incidence of complications and deaths may be related to the volume and concentration of the opaque medium employed (1, 14, 25). It is desirable, then, in all such procedures to use the smallest volume and concentration of the medium consistent with an adequate study. The ability to perform simultaneous biplane filming usually precludes the need for second injections. With intracardiac injection a smaller quantity of opaque medium is adequate than with intravenous injection. Finally, with a high exposure rate per unit time, less opaque medium is required to obtain satisfactory records.

12. *Film Viewing:* Cine studies require more time for analysis than conventional roentgen diagnostic study (26). If the viewing method is cumbersome, and analysis difficult, the value of the entire procedure may be negated.

A tentative approach to this problem was outlined, similar to that developed at the University of Rochester by Ramsey and his co-workers (29). Although opportunities for 35-mm. film viewing must be provided, the 35-mm. negative may be optically reduced to a 16-mm. positive or negative for detailed evaluation. With an analyst projector such as that developed by Weinberg (37), individual frame analysis as well as continuous motion picture analysis is possible. With biplane runs, the 35-mm. film strips may be studied side by side as individual frames using continuous 35-mm. strip film projectors, a method which Chapman utilizes (10). Structures which cannot be positively identified in individual frames may be clarified by referring to the moving strip.

#### SUMMARY

The background and objectives of biplane cineangiography have been

discussed. Emphasis has been placed on the importance of a rapid filming rate, biplane recording, short exposure times in the millisecond range, a capacity for relatively long total angiographic runs (up to 15 or 20 seconds), synchronization of film strips with electrocardiographic or intracardiac pressure recordings, controlled high-pressure intracardiac injection, diminished patient irradiation attendant upon the utilization of image intensification, adequate screen size, high-capacity equipment, and other factors which require consideration in elaboration of a satisfactory cineangiographic installation.

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## SUMMARIO IN INTERLINGUA

## Un Introduction A Cineangiocardigraphia Biplan. 1. Bases E Objectivos

Le bases e le objectivos de cineangiocardigraphia biplan es discutite. Es sublineate le importantia de un rapide exposition in le ordine de millisecundas, un capacitate pro relativamente longe sequentias angiocardigraphic total (usque a 15 o 20 secundas), synchronisation del bandas de film con registrationes electrocardiographic o registrationes de tension intra-

cardiac, controlate injectiones intracardiac a alte pression, diminuite irradiation del patiente obtenite per utilizar intensification de imagines, adequate dimensiones del ecran, apparatus de alte capacitate, e altere factores le quales require consideration in le elaboration de un satisfacente installation cineangiocardigraphic.

*Vider etiam le pagina 750.*





# An Approach to Biplane Cineangiocardiology

## 2. Equipment and Procedure

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IN AN EFFORT to attain the objectives previously outlined for satisfactory cineangiocardigraphic studies (1), an installation was planned which depended primarily upon two 11-inch intensifiers. A number of other essential components were included in the installation, and these were arranged in a fashion which has proved functional and quite satisfactory.

### THE COMPONENTS

1. *The Eleven-Inch Image Intensifier* (Figs. 1 and 2): The 11-inch diameter image intensifier manufactured by Philips of North America is a bulky unit, some 56 inches in length, weighing about 350 pounds. In principle, it is no different from the 5-inch intensifiers of the simple electron-optical type, consisting of an evacuated glass envelope with a fluorescent screen at one end and an aluminum-backed phosphor layer at the other. X-rays, having passed through the patient, produce an image on the fluorescent screen, and a photoelectric layer in back of the screen emits electrons whose point intensity is proportional to the local brightness of the screen. Thus, the fluorescent screen transforms the x-ray image into a light image, and the photoelectric layer transforms the light image into an electron image. The electrons are accelerated down the length of the tube by electrical potentials applied to electrodes in the tube, and impinge on the phosphor at the end of the tube (Fig. 3). This phosphor is 2 1/2 inches in diameter, in contrast to the 11-inch diameter of the fluorescent screen, which has a total surface area of about 95 square inches. By accelerating the electrons and reducing the size of the image, a brightness gain of about 100-fold is secured.

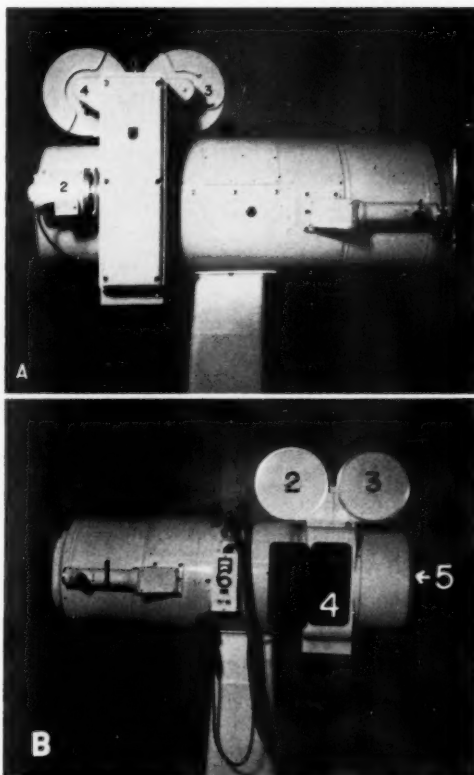


Fig. 1. Eleven-inch Philips image intensifier.

A. Horizontal unit, viewed from the right. 1. The monocular viewer. 2. The synchrotron. 3. The loading cassette of the motion picture camera. 4. The receiving cassette.

B. Horizontal unit, viewed from the left. 1. The monocular viewer. 2. The loading cassette of the camera. 3. The receiving cassette. 4. The threading elements. 5. The Schmidt mirror. 6. The fluoroscopy switch.

Each image intensifier is equipped with two monocular viewers (Figs. 1A and 1B), enabling two persons to view the image simultaneously. The viewer is somewhat awkward to use but is satisfactory for positioning the patient, determining the field size, and monitoring the study. The

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11-inch intensifier is too cumbersome to be a satisfactory general fluoroscopic device, and its design is specifically for cinefluorography.

The horizontal intensifier rests on a mobile base and may be moved away from the table when not in use. Initially, it had a vertical movement of 10 inches but, because of its bulk, the neck which sup-

ported the intensifier was subject to motion while the camera was running. Hence, it was fixed in position until a more stable and satisfactory neck could be devised. Proper right-angle positioning is therefore dependent on the vertical intensifier.

The cave was necessary in order to keep the tabletop 3 feet above the floor level. The original plans called for ceiling suspension of the intensifier, but the manufacturer suggested the possibility of fragments of lead used in construction falling

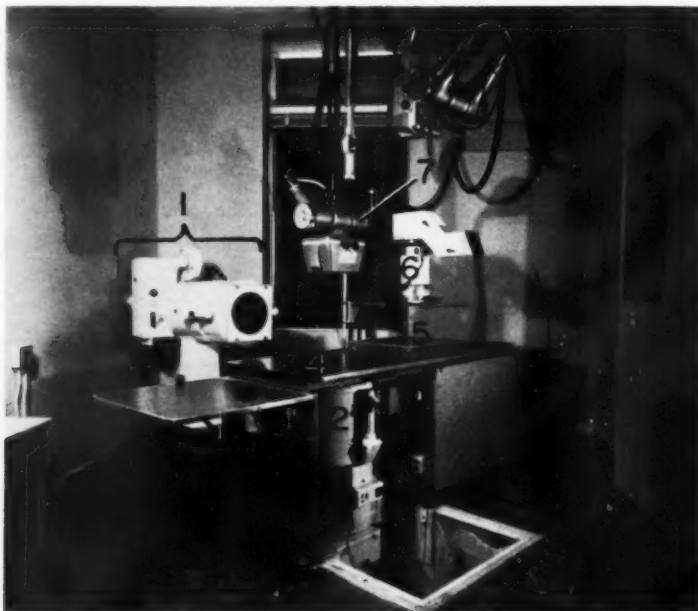


Fig. 2. Room arrangement. 1. The horizontal 11-inch image intensifier. 2. The vertical 11-inch image intensifier. 3. The cave. 4. The table. 5. The plywood cover. 6. The 5-inch image intensifier. 7. The overhead tubes.

ported the intensifier was subject to motion while the camera was running. Hence, it was fixed in position until a more stable and satisfactory neck could be devised. Proper right-angle positioning is therefore dependent on the vertical intensifier.

The vertical intensifier lies in a cave beneath the floor level (Fig. 2). The cave is 30 inches deep, 3 feet long, and 4 1/2 feet wide. It permits easy access to the camera for loading and adjustment. The intensifier is supported by a steel frame hoist, operated hydraulically. Its maximum range of vertical motion is

on the phosphor, with its face down, and thus producing artefacts. The present arrangement, with the vertical unit beneath the table, is inflexible, yet this very feature provides a safeguard against jarring and damage to a relatively sensitive and expensive instrument.

One of the major problems in the construction of the 11-inch tube was the maintenance of the vacuum. In some of the 5-inch tubes, the liberation of gas, with the consequent occurrence of white spots in the center of the tube image, had been observed. This difficulty was overcome by fitting a pump to the tube, by

means of which residual gas is continuously exhausted.

2. *The Motion Picture Camera:* The 35-mm. camera comes as an integral part of the 11-inch intensifier unit. Fundamentally simple in design and operation, it relies on Schmidt optics to augment the light gain of the intensifier. A schematic diagram of intensifier and camera (Fig. 3)

film is ready to be developed, the receiving magazine can be removed without danger of exposing the remaining film. A simple lever cuts the exposed film, and the receiving cassette is freed by the turn of a screw.

It is worth emphasizing at this point that the pressure plate places a significant amount of tension on the film surface, and

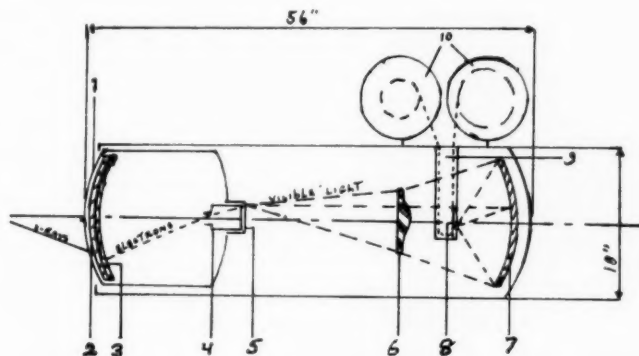


Fig. 3. Diagram of the 11-inch image intensifier and the motion picture camera (Philips). 1. The surface of the intensifier. 2. The fluorescent screen. 3. The photo-electric layer. 4. The focusing device. 5. The end phosphor. 6. The correction plate. 7. The Schmidt mirror. 8. The pressure plate. 9. The threading elements. 10. The camera magazines.

demonstrates that the image, after being focused on the output phosphor, passes through the correction plate to be reflected by a large curved (Schmidt) mirror. The shutter opening thus faces the mirror (in a direction away from the patient). At the moment of exposure, the film is curved over a pressure plate, opposite which are two runner plates by means of which adequate tension is obtained. The arc of curvature of the film corresponds to that of the mirror. The position of the runner plates must be checked prior to each study. If they are not in position, the film will be out of focus and the entire procedure will yield nondiagnostic strips.

The film can be placed easily in the loading cassette, which carries up to 1,000 feet of film. Threading the film is not complicated, and it can be automatically passed into the receiving cassette. When the cine study has been performed, and the

that the emulsion must therefore be relatively hard. Because of this factor, we have been limited in our use of film to Gevaert Scopix G film, which has an adequately hard surface emulsion. This is not true of some of the other film that has been used, although limited experience with DuPont Chronar-based film suggests that it may be satisfactory.

Film speeds of 6, 12, 16, 24, 32, and 48 frames per second may be obtained, with 48 as a maximum. The framing rate is adjusted by two knobs adjacent to the camera.

The shutter on the camera is a circular one, open  $270^\circ$  or three-quarters of the cycle for each exposure. The purpose of the  $270^\circ$  shutter opening is to gain maximum light by taking advantage of the continuous illumination of the phosphor, since no provision was made in the basic unit for synchronizing the film exposure

with tube firing. Thus, the tube fires continuously throughout the run with "free control."<sup>2</sup> When the exposure rate is 48 per second, the shutter is open about thirteen of every twenty milliseconds, since it takes about one millisecond for the shutter to open and one millisecond to close.

In setting up a biplane cineangiocardiac unit, it was thought desirable to cut the shutter opening to 180°. Although use of the afterglow of the intensifier was decreased, this seemed to be of little importance when Dynapulse timing was employed. The essential point was that it permitted the shutters of the horizontal camera to be closed when the vertical exposure was made, and *vice versa*. Scatter might thus be cut down significantly if the cameras were run synchronously but out of phase. On the other hand, the 180° shutter opening implies an effective exposure time of 8 milliseconds, a limiting factor of some importance when "free control" is employed, as it sometimes must be with heavy patients.

3. *The Table:* A specially constructed table was found necessary. The table is 6 feet long, with 30-inch extensions at each end (Fig. 2). In its center is an elevated plywood rectangle, 3 inches high, 2 feet long, and 20 inches wide, which permits the vertical image intensifier to be elevated to a satisfactory height to meet the horizontal intensifier. If necessary, the plywood cover can be removed and the intensifier can be raised to a higher position when small patients are being studied. The tabletop is movable and has a total traverse of 3 feet in each direction. When the patient has been positioned for cine studies, and the technic determined, the tabletop can be placed in the 5-inch intensifier position without disturbing the patient or changing his relationship to the table.

4. *The Exposure Meters:* Two exposure meters (Fig. 4), which are mounted

<sup>2</sup> The term "free control" is used to designate the absence of interrupted tube firing, and is in contrast to "dynapulse control," in which the tube is energized only at the moment of exposure.

adjacent to the control panel, allow the technic to be determined empirically with reasonable accuracy. A photoelectric cell attached to the camera receives the light to which the film is being exposed, scanning a central area. Thus, that portion of the subject which is in the center of the beam (presumably the critical area) determines the amount of light which reaches the photoelectric cell. The exposure meter records this amount on a scale of 0-200. The sensitivity of the meter may be varied, depending on the speed of the film. For a given type of film, an exposure meter reading of 100 is recommended by the manufacturer as optimal for film density. In practice, we have found a higher reading more satisfactory. At a given kilovoltage, the milliamperage may be adjusted to obtain the predetermined optimal exposure reading, thus allowing a simple calculation of proper technic. Since the exposure meter records the light from a limited area, any drastic collimation of the beam, or eccentric placement of the subject, must be taken into consideration in evaluation of the exposure meter reading (Fig. 3).

5. *The Dynapulse Unit:* The basic scheme of the Dynapulse unit has been thoroughly described (2). Fundamentally, it consists of a high-voltage tetrode operated in series with a diagnostic roentgen tube. This high-voltage electronic switching system permits exposures of one millisecond, or even one-half millisecond. Two such units were incorporated in the installation, one for each of the 11-inch intensifiers. The Dynapulse is triggered by a microswitch at the camera shutter, which causes the exposure to occur as the shutter opens. The length of the exposure itself is governed by the Dynapulse control panel (Fig. 4) and may extend from one to five milliseconds. With the Dynapulse, the patient receives radiation only during the exposure period, and there is precise synchronization with the shutter opening. In addition, advantage can still be taken of the afterglow of the image intensifier tube, for, in spite of the short x-ray exposure, the

camera shutter remains open for a period of about eight milliseconds, and during this period the afterglow contributes to photographic exposure of the film. Since the afterglow is a light response to an x-ray exposure made during a one millisecond period, it does not introduce significant motion of the opaque bolus or of cardiac structures.

The problem of how many times per second the Dynapulse could fire without failing to charge or discharge has not been explored by us, except to the extent that we have found it capable of firing consistently at an exposure rate of 48 times per second. A second problem concerned the total time which the Dynapulse could be employed in a single run without performance failure. Initially, it was our impression that 6 per cent of the time (60 milliseconds out of 1,000) was probably the maximum. At 48 frames per second, this would have limited us to one-millisecond exposures. In practice, we have utilized exposures of two, and even two and a half milliseconds (120 milliseconds at 48 frames, or 12 per cent) when necessary. If longer exposures are required, the exposure rate must be dropped to 32, or even 24 per second.

6. *The Generator:* The generator employed for the unit is a Muller DA1000. This is a six-valve rectified generator, in which dampening links, consisting of capacitors and resistors, are used in order to improve the voltage wave form. As a result, there is significant diminution in the ripple of the wave form, with fluctuations not exceeding 10 per cent of the peak value. The generator is capable of 1,000 ma at 90 kv, or 400 ma at 125 kv. Both tubes are supplied by the generator, as is the 5-inch image intensifier tube which is a part of the overall unit.

7. *The X-Ray Tubes (Fig. 2):* Philips 125-kv tubes are utilized. These are rotating anode tubes, with 0.3-mm. and 1.5-mm. focal spots. For the 11-inch image intensifiers, the 1.5-mm. focal spot is employed, since the capacity of the smaller focal spot would be exceeded by the

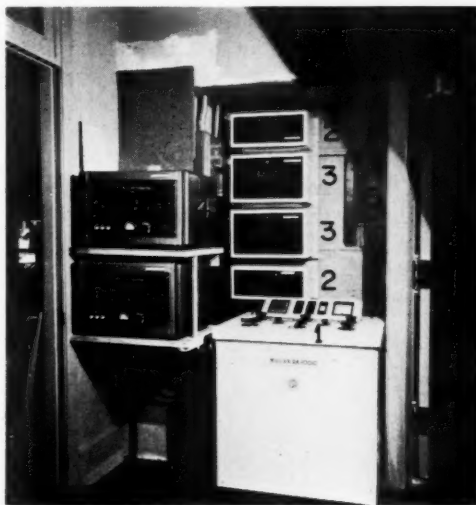


Fig. 4. The controls. 1. The central control panel. 2. The timers. 3. The exposure meters. 4. The Dynapulse control. 5. The lead-glass window.

high currents attendant upon use of the Dynapulse unit.

Both tubes are suspended from the ceiling and may be moved out of the way during preliminary procedures. The collimating devices are built in at the face of the tube, and there is a central light localizer.

8. *The Control Panel (Fig. 4):* The Muller 1000 DA control panel is easy to operate and has been readily adapted to biplane cineangiocardiology studies. Fluoroscopy, with both 11-inch image intensifiers and the 5-inch image intensifier, is mediated by the control panel, although the actual fluoroscopic switches are available to the operator at the table. When cinefluorography is undertaken, the switch is readily made through the control panel, and separate knobs determine the milliamperage on the horizontal and on the vertical tubes. The kilovoltage is preset, and must be the same for both planes, although it is possible to vary the time and the milliamperage independently with the Dynapulse units. When "free control" is employed, the milliamperage can be altered selectively. A switch which determines whether a single plane or both planes are to be employed has been placed



on the panel, and another switch determines whether or not the Dynapulse unit is in the circuit. The controls are located outside the room, but a lead-glass window permits easy viewing of the entire procedure.

9. *The Synchronizing Device:* Since it was a matter of some importance to have the two planes synchronized, not only in order to determine the relationship of the

made. This can be obtained at all exposure rates.

11. *The Recording Instrument:* A multi-channel recorder records simultaneously the electrocardiographic deflections on one channel, the contacts made at the moment of exposure on a second channel, and at times the intracardiac or arterial pressures on other channels (Fig. 5). Continuous phonocardiographic recordings are now



Fig. 5. Simultaneous electrocardiographic, right ventricular pressure, and exposure recording.

The top line records the deflection when the exposure recording contact is closed at the time of shutter opening during a run of 48 frames per second. Below are the electrocardiographic and right ventricular pressure tracings.

exposure of one plane to the other, but also so that scatter might be diminished, it was necessary to incorporate a synchronizing device into the unit. This was accomplished by introducing a synchronomotor (a selsyn, Fig. 1A) which assures a constant relationship between the shaft rotating one camera shutter and that rotating the other camera shutter.

10. *The Exposure Recording Contact:* On the shaft which rotates the camera shutter there is a small contact which closes precisely at the time when the Dynapulse fires. This contact is made for  $180^\circ$  rotation of the shutter, and is broken for the other  $180^\circ$ . The contact is recorded on a continuous electrocardiographic strip and allows determination of the moment in the cardiac cycle when the exposure is

being attempted and should permit multiphasic study, in which the anatomic changes during the study can be correlated with physiologic, sound, and electrical events.

12. *The Automatic Pressure Injector:* The automatic pressure injector devised by Gidlund has a number of important features (3). The injection speed can be easily varied by altering the pressure of injection. If desirable, a constant speed of injection can be obtained, even though different catheter sizes are employed, by varying the pressure according to a series of volume-time curves which have been established. The temperature of the contrast medium can be maintained at a desirable level, diminishing the viscosity and decreasing the tendency of concentrated

contrast media to crystallize. Finally, the injection may be remotely controlled, reducing the roentgen radiation to operating personnel. The syringe has proved durable. The problem of air embolism has been well thought out and steps have been taken for its prevention.

13. *The Five-Inch Image Intensifier* (Fig. 2) is a conventional Philips 5-inch amplifier, with a mirror viewer permitting one

#### OPERATIONAL ASPECTS

1. *Before the Patient Arrives:* Some hours before the procedure is to be done, a preliminary check list is reviewed to make sure that all necessary items are available. These include the intravenous stand, tubing and fluid, heparin, and sterilized syringe of the pressure injector, a compressed air cylinder, catheters, the opaque medium, the cut-down tray, the resuscitation tray,

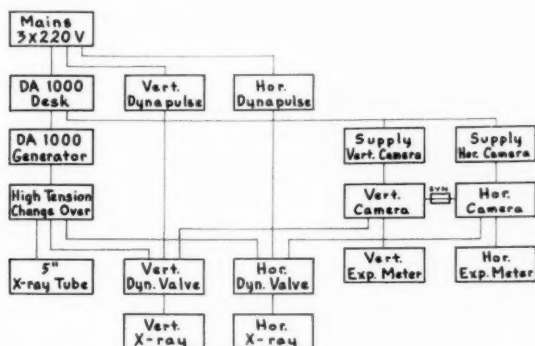


Fig. 6. Schematic diagram of components. The main lines supply the 1,000-ma generator and the Dynapulse units. The Dynapulse controls are triggered by the shutter opening on the camera. The DA 1,000 desk (the central control panel) contains the switch which determines whether Dynapulse or "free control" is to be employed, and a second switch which permits single or biplane operation. The selsyn motor ("syn") keeps the cameras synchronized.

observer to use it. It is employed for fluoroscopy only and not for cine work. Because of its flexibility, it permits catheter placement and physiologic studies prior to cineangiography. It has a traverse of 3 feet along the length and width of the table.

14. *The Timers* (Fig. 4): The total length of the study is set by dials on the timing box and may extend up to sixty seconds. The timing box is located above the control panel, adjacent to the light meter, and also contains the switch which starts the camera.

15. *The Circuits:* A schematic diagram of the interconnections of the components in the unit is shown in Figure 6. When the Dynapulse is switched out of the system, and the unit runs on "free control," the x-ray tubes are triggered directly by the central control panel.

sand bags, lead aprons, the electronic recording equipment, etc.

The amount of film in the camera is noted, and reloading is performed if necessary. The pressure plates and runner plates are inspected at the end of loading. These must be examined prior to each procedure. The filming rate is also set at this time.

The overhead tube is aligned with the vertical intensifier, and the horizontal intensifier is placed precisely at right angles to the table and to the vertical intensifier. The generator and the Dynapulse units are tested to make sure that they are in working order.

2. *With the Patient Present:* The patient is placed on the table with the head toward the 5-inch image intensifier and the chest overlying the 11-inch intensifier. The field size and the patient's



## CINEANGIOCARDIOGRAPHIC OPERATING CHECK LIST

NAME _____	No. _____		DATE _____	
	Vert.	Horiz.	Vert.	Horiz.
1. Load camera	_____	_____	23. Load pressure injector	_____
2. Adequate film	_____	_____	24. Physiologic studies	_____
3. Pressure, runner plates	_____	_____	25. Determine injection site	_____
4. Exposure rate	_____	_____	26. Tie catheter in	_____
5. Tube, screen align.	_____	_____	27. Pt. to cine position	_____
6. Preliminary film	_____	_____	28. Recheck position	_____
7. Exposure record contact	_____	_____	29. Close viewers	_____
8. Pressure cylinder	_____	_____	30. Elevate vert. intensifier	_____
9. Generator	_____	_____	31. Attach injector cylinder	_____
10. Dynapulse	_____	_____	32. Check pressure	_____
11. Amplifier switches on	_____	_____	33. Firing cord	_____
12. Position of patient	_____	_____	34. Attach injector to catheter	_____
13. Collimate beam	_____	_____	35. Check catheter stopcock	_____
14. Ink marks	_____	_____	36. Cock injector lever	_____
15. Case number	_____	_____	36A. Switch ready	_____
16. Measuring marker	_____	_____	37. Cameras on	_____
17. Attach EKG.	_____	_____	38. Time of run	_____
18. Exposure meter dials	_____	_____	39. Biplane on	_____
19. Technic	_____	_____	40. Dynapulse on	_____
Free: kv	_____	_____	41. Monitor viewer open	_____
ma	_____	_____	42. Kv at zero	_____
Dynapulse: kv	_____	_____	43. Trigger switch to prep position	_____
ma and time	_____	_____	44. Kv to preset level	_____
20. Pt. to 5-in. intens.	_____	_____	45. Press, hold dyn. buttons	_____
5-in. intens. controls	_____	_____	46. Trigger switch to on	_____
21. Insert catheter _____ I.V. drip	_____	_____	47. Injector switch to on	_____
22. Test dose _____ Heparin	_____	_____	48. ma and light meter figures	_____

Fig. 8. Operating check list.

In addition, the light meter reading cannot be simply transposed. A Dynapulse run with a light meter reading of 75 has been found empirically to correspond to a "free control" reading of 120 in the degree of film blackening obtained. On this basis, the factors needed with Dynapulse are increased until a light meter reading of 75 is obtained, and the procedure may now be started.

The limb leads of the electrocardiogram are placed on the patient, and the exposure recording contact is attached to the multi-channel recorder. The patient is then

moved beneath the 5-inch intensifier. The cut-down is done, the catheter is inserted and, by means of a three-way stopcock, a heparinized intravenous drip and the pressure recording device are attached. Under fluoroscopic guidance, and with oscilloscopic monitoring of the electrocardiogram, the catheter is placed in the superior vena cava, the right atrium, the right ventricle, and the pulmonary artery. Appropriate pressure tracings are obtained, and blood samples are subjected to analysis by the cuvette oximeter. On the basis of the physiologic studies and a prior appraisal

of clinical and conventional radiologic studies, the desired position of the catheter tip is determined and the catheter is fixed in place. A sensitivity test is performed, and the patient is then moved back into the cine position.

The patient's position is again checked fluoroscopically while the pressure injector is being loaded and the pressure set. The injector is attached to the catheter, and the injector lever is cocked to the firing position. All personnel now leave the room, unless the procedure is to be monitored on the monocular viewer of the 11-inch intensifier. The cameras are started, the total time of the run is set, and both biplane Dynapulse switches are turned on. With kilovoltage, milliamperage, and time set, the tubes are energized and simultaneously the injector switch is pushed. Throughout the run, a permanent electrocardiographic and exposure record is obtained for subsequent analysis. It has been found essential to construct an operating check list in order to lessen the possibility of human error (Fig. 8).

After the procedure, the catheter is quickly removed, the wound is closed, and the patient is returned to his room.

The film is usually processed within an hour and is studied both as a motion picture and as multiple still frames.

#### SUMMARY

A description of an installation employed in biplane cineangiocardiology has been given. The basic components are two 11-inch image intensifiers, with attached 35-mm. motion picture cameras. Procedural aspects have been briefly alluded to, and the need for an operating check list has been mentioned.

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#### SUMMARY IN INTERLINGUA

##### Un Introduction A Cineangiocardigraphia Biplan. 2. Equipamento e Technica

Es describe un installation empleate pro le cineangiocardigraphia biplan. Le componentes fundamental es duo intensificadores de imagine de 11 pollices, con duo attachate cameras cinematographic de 35 mm. Duo exposimetros montate adjacente al tabula de manovra permette un empiric determination del technica a emplear, con bon grados de precision. Omne intensificador de imagine es equipate con

duo oculares monocular, de maniera que duo personas pote vider le imagines simultaneamente.

Le technica angiocardigraphic empleate con iste apparato es delineate e emphase special es placiante super le importantia de un lista de detalles de manipulation pro reducir al minimo le possibilitate de errores human. Un tal lista es reproducite.

*Vider etiam le pagina 740.*



## Generalized Skin Reaction Following Deep X-Ray Therapy<sup>1</sup>

ANDREW P. DEDICK, JR., M.D., and VINCENT M. WHELAN, M.D.

**G**ENERALIZED SKIN reaction following deep radiation therapy is rarely encountered and even more rarely recognized once it has occurred. The primary reaction at the treatment site is familiar to all radiotherapists. At least two other types of cutaneous reactions can occur: (a) a localized form, so-called infectious eczematoid dermatitis confined to the irradiated area and adjacent skin, reported by Castigliano (2) in 1941 and again by Swift (4) in 1956, and (b) a relatively infrequent generalized form, or so-called erythema multiforme, first described in 1903. The purpose of this report is again to call attention to this generalized type of reaction, to report 3 cases, and to add 2 observations not previously recorded.

Arnold (1) gives an excellent historical account of the reaction and credits Guido Holzknecht of Vienna with the first published report. Davis and Pack (3), in 1952, reviewed the pertinent literature, collecting some 32 recognized examples, and added 5 cases of their own. They suggest that the condition is possibly more common than these figures would indicate but, because of unfamiliarity with the condition, the radiotherapist, dermatologist, and surgeon erroneously regard it as an allergic response to drugs or food.

Since the publication by Davis and Pack, 3 cases have been personally encountered. These are the subject of the present paper. As observed by the above authors, a prodromal period characterized by fever and malaise followed completion of the irradiation and preceded the generalized skin eruption. This prodromal phase lasted from five days to six weeks. In no instance was there clinical or laboratory evidence of infection or allergy. Only one patient was taking any medicine, a multivitamin preparation. All 3 received approximately the same amount of radia-

tion, over the same time interval, to relatively the same area; all were treated with 200 kv. radiation, half-value layer, 1.2 mm. Cu.

**CASE I:** A 54-year-old white female was treated postoperatively for carcinoma of the right breast. The following areas were irradiated: anterior and posterior right supraclavicular areas, 10 × 15-cm. ports, 2,400 r/air; the right internal mammary chain, 6 × 15-cm. port, 3,200 r/air; the operative site, cross-fired from right to left and left to right, 10 × 15-cm. ports, for a total of 2,000 r/air. Treatment was begun on June 29, 1953, and completed July 31. On Aug. 6, a moist desquamation was noted at the treatment sites. On Aug. 21, this was resolving nicely, although the patient complained of considerable malaise and slight fever. On Sept. 15, a diffuse morbilliform eruption, with severe itching, developed over the entire body, associated with a slightly elevated temperature and pronounced weakness. The skin eruption spared the treatment sites and was most marked in the postauricular area, both gluteal and right axillary folds, and beneath the left breast. Pyribenzamine, 50 mg., was given immediately and continued, every four hours, for the next week. The eruption resolved slowly and in four weeks was gone, except in the postauricular area and beneath the left breast. No history of allergy was elicited.

The patient, who is known to be alive and well today, was last seen in October 1953, at which time the skin was clear and manifested no evidence of recurrence or persistence of disease.

**CASE II:** A 71-year-old white male was treated for inoperable right upper lobe bronchogenic carcinoma from Aug. 2 to Sept. 3, 1954. Radiation was delivered through anterior, posterior, and lateral 10 × 15-cm. ports to the right upper lobe and mediastinal area, 100 r in air being given daily for a total of 2,400 r to each port. The skin reaction at the treatment sites, a moist desquamation, was at its height on Sept. 8, 1954. The remainder of the skin of the body was clear. On Oct. 7, 1954, a generalized morbilliform eruption, with itching, occurred over the trunk, both extremities, and the neck. Because of our experience with Case I, it was decided that this was a radiation reaction, and cortisone therapy was instituted. The patient received 100 mg. by mouth immediately, and two further doses of 100 mg. each on the first day. He was given 100 mg. twice daily for the next three days and then 50 mg. twice daily for seven days, after which the drug was gradually discontinued. The skin reaction largely disappeared the day

<sup>1</sup> Accepted for publication in August 1958.

after treatment with cortisone began, and continued to resolve, clearing entirely in eight days. Itching, which was severe, abated after the second dose of cortisone. Again, the generalized reaction did not involve the previously treated skin areas.

CASE III: A 63-year-old white female was treated postoperatively for carcinoma of the right breast from Feb. 13 to March 21, 1957. The following areas were treated: the supraclavicular area, anterior and posterior, 10 × 15-cm. ports, 2,000 r/air; the right internal mammary node area, 6 × 15-cm. port, 3,200 r/air; the operative site, cross-fired from left to right and right to left, 10 × 15-cm. ports, 2,000 r/air. A weeping erythema developed at the treatment sites. On April 8, 1957, a diffuse scarlatiniform and morbilliform eruption occurred over the face, head, extremities, and trunk. The patient had a slight fever and marked malaise. The eruption did not occur in the supraclavicular area, which had been previously irradiated and healed. A single dose of 100 mg. of Meticorten was given intramuscularly, followed by 40 mg. three times daily by mouth for one week. The drug was gradually reduced during the next two weeks, and was then discontinued. The response was dramatic: within twenty-four hours the eruption had largely cleared and the patient felt greatly improved. Itching, which had been severe, was considerably diminished. The skin was clear by May 10.

#### DISCUSSION

Two observations are added to those previously reported in the literature: (a) the skin reaction appears to spare the area which has been previously irradiated, and (b) steroid therapy—cortisone or Meticorten—induces an immediate favorable response.

Case I responded fairly well to Pyribenzamine, but resolution was not complete for four weeks. Cases II and III were treated with steroids, with dramatic response. Itching and erythema abated within twenty-four hours; the skin cleared in eight days in one case and within two weeks in the other. Thus, the severity and duration of the skin changes were significantly reduced by this treatment.

The mechanism of the reaction is not well understood. Earlier observers attributed it to a viral or bacterial agent. Later investigators, however, excluded the

theory of infection. An allergic response to a toxin resulting from the action of x-rays on normal and neoplastic tissue is now postulated. To date, no more pertinent explanation has been presented. Previous authors have reproduced the generalized skin reaction on re-exposure to x-radiation, which supports the allergic theory.

Davis and Pack noted that patients who manifested this type of reaction usually had radiosensitive tumors, with a good response to x-ray treatment. One of our patients with carcinoma of the breast is alive and well today without clinical evidence of disease; the other has roentgen evidence of bone metastasis. In the case of bronchogenic carcinoma, there was no reduction in tumor size following irradiation, and the patient died of metastases six months following completion of therapy.

#### CONCLUSIONS

1. Generalized skin eruption due to local roentgen therapy is infrequently encountered and seldom recognized once it has occurred.
2. A prodromal period of several days to several weeks precedes the skin manifestations.
3. The skin at the irradiated sites is not involved in the generalized reaction.
4. Steroid therapy controls the condition much more rapidly than antihistamine drugs.

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## SUMMARIO IN INTERLINGUA

**Generalisate Reactiones Cutanee Post Roentgeno-Therapia Profunde**

In rar casos le reaction cutanee a therapia a radiation profunde prende le forma de un eruption generalisate (erythema multiforme) le qual es frequentemente misinterpretate como le resultado de un allergia dietari o drogali. Un periodo prodromal que dura inter plure dies e plure septimanas e que es characterisate per febre e malaise precede le apparition del manifestationes cutanee.

Tres casos es reportate, e duo observationes non previemente registrate es facite: (1) Le reaction pare sparniar le area ir-

radiate, e (2) therapia a steroides (cortisona o Meticorteno) induce un immediate responsa favorabile.

Le mechanismo del reaction non es cognoscite, sed illo da le impression de representar un responsa allergic a un toxina resultante ab le action de radios X super histos normal e neoplastic. Il existe apparentemente un correlation inter illo e le radiosensibilitate del tumor. Le plus grande le radiosensibilitate, le plus probable le occurrentia de un reaction generalisate.



## Lipomas of the Colon

Report of a Case in a Patient with Multiple Neurofibromatosis (von Recklinghausen's Disease)<sup>1</sup>

LIEUT. C. WILLIAM ROGERS, MC, USN

**L**IPOMA OF THE colon is the second most common benign tumor of the large bowel (4), with adenomatous polyps ranking first in frequency. Although lipomas are regarded as uncommon in the gastrointestinal tract, they have been the subject of numerous case reports and reviews during the past decade (4, 6, 7).

mention was found of a patient with von Recklinghausen's neurofibromatosis.

### CASE REPORT

The patient was a 34-year-old white female, in no acute distress, whose past history was significant in that she had had many subcutaneous nodules excised in the past ten years and a mass removed from the spine four years previously. The spinal

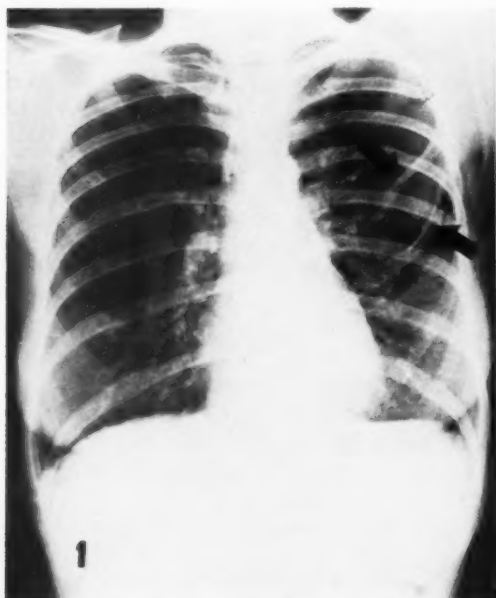


Fig. 1. Postero-anterior film of the chest showing the spreading of the anterior third and fourth ribs on the left by what is presumed to be a neurofibroma.

Fig. 2. Spot-film showing an intussusception at the hepatic flexure. Note the filling defect at the termination of the barium column and the "coil spring" appearance caused by the protrusion of the intussusceptum into the lumen of the colon distal to the lipomata.

The following case is reported because of the association with von Recklinghausen's disease. It is not known whether the coexistence of the two conditions was a chance occurrence or whether they were related causally. In the several hundred reports of colonic lipoma no specific

mass was shown microscopically to be a neurofibroma. The present illness dated back to one month prior to admission, beginning with intermittent crampy abdominal pain associated with diarrhea. The patient described the pains as quite similar to labor pains. In addition, she had discovered a small, freely movable mass in the right lower quadrant of the abdomen, which seemed to be associated with pain of the same character.

<sup>1</sup> From the Department of Radiology, U. S. Naval Hospital, Bethesda, Md. Accepted for publication in August 1958.

The opinion or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

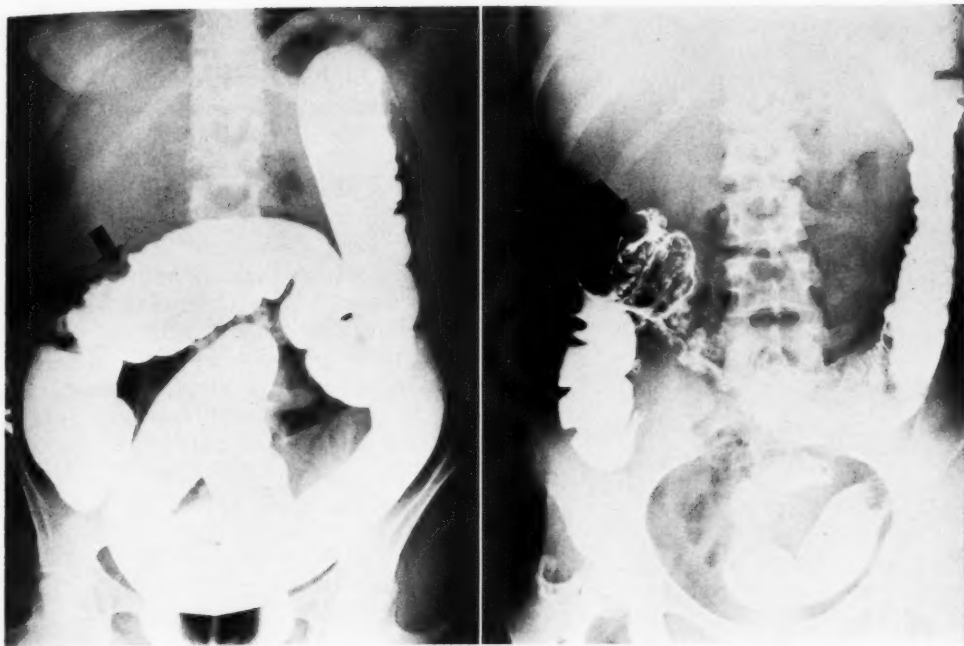


Fig. 3. Two projections clearly demonstrating the filling defects at the hepatic flexure due to intramural lipomas (arrows). The intussusception had reduced spontaneously between the time fluoroscopic study was performed and these films were obtained.

Physical examination revealed the right lower quadrant mass, multiple subcutaneous nodules, *café au lait* spots, and operative scars. The peristaltic sounds were normal at the initial examination but later, during an attack of abdominal pain, peristaltic rushes were audible.

Laboratory studies, including blood urea nitrogen, serology, stool examination for ova and parasites, serum electrolytes, bleeding and clotting time, and electrocardiography, were all within normal limits. A roentgenogram of the chest revealed a widening of the intercostal space between the anterior third and fourth ribs on the left, with slight distortion of their cortical margins presumably due to pressure atrophy from an intercostal neurofibroma (Fig. 1). An excretory urogram was obtained but disclosed no abnormalities.

Barium enema examination showed an intussusception at the hepatic flexure, producing complete obstruction to the barium column (Fig. 2). Follow-up films showed that the intussusception had been reduced and revealed two oval filling defects in the wall of the bowel (Fig. 3). A diagnosis of "intramural tumor of the colon" was made. At laparotomy on Aug. 13, 1957, four intramural lipomas of the hepatic flexure were found, and a right colectomy with ileo-colostomy was performed. The postoperative course was uneventful and the patient was discharged on the seventh postoperative day.

#### DISCUSSION

Since the diagnostic aspects of colonic lipoma have been well covered in other articles, notably by Henderson *et al.* (4), a complete discussion will not be given here. The case reported is typical in the occurrence of crampy abdominal pain and the finding of an intussusception. These two factors lead one to suspect a lipoma, and the finding of filling defects in the hepatic flexure, suggestive of an intramural mass, adds to the suspicion. Unfortunately, there is no good method of ruling out a malignant neoplasm, and surgery is therefore indicated in every case (5).

Neurofibromatosis is classified as one of the congenital ectodermoses, sometimes called neurocutaneous syndromes, which include tuberous sclerosis, angiomas of the cerebri, and von Hippel-Lindau's disease (1). Most authors point out that there is no sharp demarcation within this group of diseases and that findings typical of one of the syndromes may be present in





Fig. 4. Photograph of the operative specimen, which includes almost the entire hepatic flexure and a portion of the mesentery. The largest of the lipomas is easily visible.

another. An exception to this view is proposed by Schull and Crowe (8), who state that any variation from the classical symptoms is probably caused by a genetic mutation.

Epilepsy, mental retardation, and bony changes other than those secondary to the neurofibromata were absent in this patient. There is nothing to suggest other than a classical case of von Recklinghausen's disease except the visceral tumors. These tumors are seen with great frequency in tuberous sclerosis, and it is felt by the writer that the case lends support to the belief that the neurocutaneous syndromes are not clear-cut entities but may overlap, with the exact diagnosis dependent upon

the degree to which the classical findings are manifest. This case is reported to add to the literature another *forme fruste* of multiple neurofibromatosis.

#### SUMMARY

A case of von Recklinghausen's multiple neurofibromatosis is presented in which there were associated colonic lipomas causing intussusception and intermittent obstruction. Such visceral tumors are of common occurrence in tuberous sclerosis, and their presence in this instance is felt to indicate the close relationship between all the diseases commonly grouped in the category of neurocutaneous syndromes.

ACKNOWLEDGMENT: I would like to express my appreciation to Comdr. Robert P. Dobbie, MC, USN, for his description of the operative findings.

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#### SUMMARY IN INTERLINGUA

**Lipomas Del Colon: Reporto De Un Caso In Un Patiento Can Neurofibromatosis Multiple (Morbo De Von Recklinghausen)**

Es presentate un caso del multiple neurofibromatosis de von Recklinghausen con le qual esseva associate lipomas colonic que causava intussusception e obstruction intermittente. Tal tumores visceral occurre

frequentemente in sclerosis tuberosa. Lor presentia in iste caso pare indicar un intime relation inter omne le morbos que es generalmente gruppate in le categoria de syndromes neurocutanee.

# Plastic and Nylon Applicators for Cobalt Treatment of Cancer of the Uterine Cervix by the "Revised" Manchester System<sup>1</sup>

J. G. HOCKIN, M.D., and F. D. HANKINS, M.D.

THIS PAPER presents a design of plastic ovoids and nylon tandems for use in cobalt application in the treatment of cancer of the cervix by the "revised" Manchester system. For a discussion regarding the "revised" Manchester and Manchester systems the reader is referred

## CONCLUSION

A plastic and nylon modification for Cobalt in the treatment of cancer of the cervix by the "revised" Manchester system is described<sup>2</sup>.

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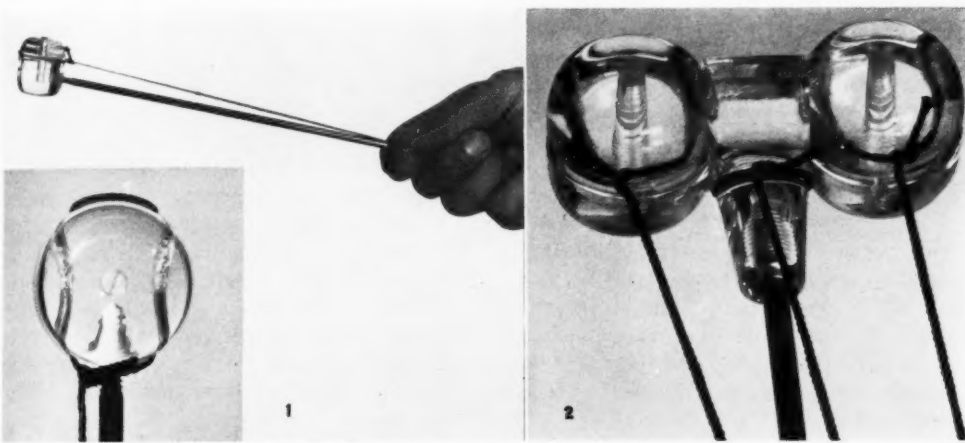


Fig. 1. Plastic ovoid with 12-inch inserter is shown. At lower left is a close-up view of the top of the plastic ovoid, demonstrating the screw top and linen thread.  
Fig. 2. The completed interlocked unit showing shoulder on the spacer.

to the current literature (1-5). The plastic and nylon applicators are essentially the same as those designed for radium (6). Each unit of cobalt has an actual and overall length of 15 mm. The strength is about 1.43 mc, which is equivalent to 2.5 mg. of radium. The following improvements have been added:

1. Screw caps to the ovoids so that cobalt can be permanently mounted in the plastic containers (Fig. 1).
2. Shoulders on spacers and washers, which aid in packing the vagina, in that more mass is present, thus minimizing the danger of slippage or rotation (Fig. 2).

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<sup>1</sup> Accepted for publication in August 1958.  
<sup>2</sup> Manufactured by Medical Research Specialties Company, Loma Linda, Calif. Distributed by Abbott Laboratories.

## SUMMARIO IN INTERLINGUA

**Applicatores De Plastico E Nylon Pro Le Tractamento A Cobalt De Cancere Del Cervice Uterin  
Per Medio Del "Revisionate" Systema Manchester**

Es describe un modification, facite de plastico e nylon, del applicator de cobalt in le tractamento de cancro cervical secundo le "revisionate" systema Manchester. Illo include coperculos a helicoides pro le ovoi-

des, rendente possibile montar le cobalt permanentemente in le receptaculos de plastico, e projecturas pro le spaciatores e le obturatores que adjuta in impacchar le vagina.



# EDITORIAL

## Teaching Objectives in Diagnostic Roentgenology

Does diagnostic roentgenology realize that its progress has greatly broadened its teaching obligations? Is the specialty aware of the growing similarity between its teaching responsibilities and those of the other clinical services? Is an adequate response being made to these developments?

There are reasons to doubt that a positive answer can be given to these vital questions. Consider, by way of comparison, the instruction of undergraduates in surgery. They are taught the indications for many operations and shown the beneficial results, complications, and sequelae of the various procedures. Even technical aspects receive some attention, so that altogether a vast amount of general surgical knowledge and understanding is imparted. At the same time, however, a sense of restraint is developed, stemming from an appreciation of the grave responsibilities entailed in actual surgical practice.

In essence the objectives of this undergraduate instruction are to enable students to recognize competent surgery and to teach them how best to utilize its services for their patients' needs. Postgraduate training, obtained in the residency or preceptorship, prepares the physician to assume clinical responsibility by the actual performance of surgery. Consequently two broad types of surgical teaching exist: one for the resident in surgery, the other for the remainder of the profession, including the medical student.

These considerations generally hold true also for diagnostic roentgenology, first because the specialty has progressed to a point where physicians no longer can practice satisfactorily without a general knowledge of this subject, and second because there exists a close correlation between the

clinical responsibilities of surgical and roentgenological practice. Let us review briefly evidence supporting these two assertions.

The breadth and complexities of the roentgenological information already accumulated are immense. The rapidity with which developments continue to appear add constantly to the task of keeping abreast. How, then, can the modern physician expect to practice without a broad understanding of the accomplishments, limitations, and hazards of this form of medical practice?

The similarity between the clinical responsibilities of surgical and roentgenological practice is less obvious, since the dire consequences of surgical ignorance or carelessness are so often direct and dramatic. However, the seriousness of a roentgenological misdiagnosis is not lessened because the misfortune it creates is more indirect and insidious. The error is simply more difficult to recognize and to overcome. Roentgenologists know that morbidity and mortality rates are an inescapable part of their practice.

In order to respond successfully to the teaching demands now thrust upon them, roentgenologists must first be certain that the conditions necessary to the attainment of these objectives prevail. What are the more important of these conditions?

There must be instructors with the teaching skill and experience to develop in students an understanding of the attitudes, principles, and ideals embodied in the specialty. Furthermore, these teachers need an adequate background of selected and tested roentgenological knowledge and experience. An independent, well staffed x-ray department is essential. Because effective medical instruction is not possible

in a void, an efficient radiological practice should be in operation. A successful teaching program can be conducted only in an atmosphere where dedication to patient service, roentgenological progress, and research are the primary considerations.

By contrast to all this, the fragmentation of diagnostic roentgenology that is permitted in some institutions is shocking. When roentgenological practice and teaching are taken over piecemeal by separate sections of gastroenterology, neurology, pediatrics, orthopedics, and urology, a chief obstacle is raised to effective teaching. The basic principles vitally important for a broad comprehension of x-ray diagnosis are not presented, and teaching obviously lacks authority, coherence, and perspective.

One naturally expects a significant amount of information about x-ray diagnosis to be contributed by the other clinical specialties, just as the roentgenologist renders judgment on their work in the pursuit of his own activities. This interchange, inherent in the freedom of academic expression, contributes a healthy sense of balance and proportion to all medical instruction. The important point, however, is that diagnostic roentgenology be able to speak for itself in a unified and independent manner, and with authority.

In brief, a foundation must first be established which will enable one to teach from a position of respect. After this is accomplished there are a number of aspects deserving emphasis in a program of instruction designed to impart general knowledge and understanding of diagnostic roentgenology to students and physicians. The specialty's wide usefulness in medicine should be made apparent. The need to keep medical radiation exposure of the public to a minimum must be explained. The existence of morbidity and mortality rates in diagnostic roentgenology should be made clear. Students must discern that roentgenologists are as aware of the limitations of their method as they are of its advantages and useful-

ness. It should be taught that objectivity is an essential attitude for dependable x-ray interpretation and that clinical bias often jeopardizes such openmindedness.

Gradually the realization will grow that "seeing a lot" of films means little in comparison to being able to comprehend underlying principles. Certainly it is far more important that students be made to understand the role of roentgenology in the detection, diagnosis, and management of diseases than that one try to teach them how to diagnose lung cancer or tuberculosis from films. Unfortunately the latter is a common objective, but it is a wholly impractical one because it is impossible of attainment during the medical course.

It will become apparent that it is training and experience which enable the roentgenologist to accomplish his results in a simple, reliable, and safe fashion. In other words, it is most important that an appreciation of the existence of definite standards in the practice of diagnostic roentgenology be developed. Throughout the period of instruction, the value of a broad background in medicine, co-operation with other physicians and specialties, familiarity with their problems and concepts, and personal contact with patients must be stressed. With considerations such as these for guideposts, the proper objective of medical student instruction in x-ray diagnosis will be realized.

While diagnostic roentgenology has advanced on most fronts, there is a failure to make full and efficient use of the roentgenological services generally available, and there is a serious lack of insight into the responsibilities entailed in the practice of x-ray diagnosis. It is apparent that, until diagnostic roentgenology clarifies and revises its teaching objectives and fits them to its changing responsibilities, it will fail to obtain the understanding and support required for its full development. Indeed, it is no exaggeration to state that the future of the specialty is going to be determined largely by the type of teaching it brings to others, especially to medical students. ROBERT S. SHERMAN, M.D.



## ANNOUNCEMENTS AND BOOK REVIEWS

### AMERICAN BOARD OF RADIOLOGY NOTICE

The American Board of Radiology will not conduct a Special Examination in Nuclear Medicine for diplomates in Radiology or Therapeutic Radiology in June 1959. Candidates desiring this examination will be accommodated on Dec. 5, 1959, at the Shoreham Hotel, Washington, D. C. The deadline for filing applications is Aug. 1, 1959.

The Fall Examination will be held at the Shoreham Hotel, Dec. 6-9, 1959. The deadline for filing applications is July 1, 1959. Candidates in Diagnostic Roentgenology may expect to be examined in Physics.

### GREATER ST. LOUIS SOCIETY OF RADIOLOGISTS

The following have been recently elected to office in the Greater St. Louis Society of Radiologists: Thomas F. Maher, Jr., M.D., President; Charles J. Cherre, M.D., Vice-President; Harvey A. Humphrey, M.D., 510 S. Kingshighway, St. Louis 10, Mo., Secretary-Treasurer.

### SOCIEDAD ARGENTINA DE RADIOLOGÍA

Recently elected officers of the Sociedad Argentina de Radiología are: President, Dr. Alberto Piernes; Vice-President, Dr. Francisco P. Cifarelli; Secretary-General, Dr. Edgardo O. Olcese; Treasurer, Dr. Carlos M. Oliver; Assistant-Treasurer, Dr. Manuel Malenchini; "Vocales," Dr. Victorino D'Alotto and Dr. Pedro A. Maissa. The official address of the Society is Sante Fé 1171, Buenos Aires, Argentina.

### ROCKY MOUNTAIN RADIOLOGICAL SOCIETY

The next annual meeting of the Rocky Mountain Radiological Society will be held Aug. 20-22, 1959, in the Shirley-Savoy Hotel, Denver, Colo. The guest speakers and their subjects are as follows:

Dr. Eugene P. Pendergrass, of Philadelphia, Penna.: "Some Intangibles Concerning Cancer"; "Some Thoughts Concerning the Treatment of Inoperable Carcinoma of the Breast"; "Pneumoconiosis."

Dr. Philip J. Hodes, of Philadelphia: "Altered Cerebral Hemodynamics; Manifestations of Intracranial Disease"; "Rare Pulmonary Diseases: Their Roentgen Manifestations"; "Medical Meddlers: What Price Insecurity?"

Dr. Franz Buschke, of San Francisco, Calif.: "The Treatment of Advanced Carcinoma of Head and Neck"; "Common Misconceptions in Radiation Therapy."

Dr. Owings W. Kincaid, of Rochester, Minn.:

"Abdominal Aortography"; "Experiences with Angiography as a Guide to Mediastinal Exploration"; "Roentgenologic Diagnosis of Operable Heart Disease."

Dr. Magnus I. Smedal, of Boston, Mass.: "Therapeutic Uses of Low Megavolt Electrons"; "Observations on the Cause of Arm Edema Following Radical Mastectomy."

### OKLAHOMA STATE RADIOLOGICAL SOCIETY

Annually at the University of Oklahoma School of Medicine the house officers of University Hospital and affiliated hospitals have an "Intern-Resident Program Day." At this all-day meeting, papers are presented by house staff members on subjects of their choice. The date for 1959 is May 23.

At the January meeting of the Oklahoma State Radiological Society a resolution was passed offering \$100 as an additional award to any prize winner whose paper deals with some phase of radiology. This award will be offered annually.

### COURSE ON DIAGNOSTIC AND THERAPEUTIC USES OF RADIOIODINE

The Department of Radiology of the University of Texas Southwestern Medical School, Dallas, will give an intensive didactic, laboratory, and clinical course in The Diagnostic and Therapeutic Uses of Radioiodine, June 15-20, 1959. The faculty will be the staff of the Department of Radiology and the visiting lecturer will be Leslie J. DeGroot, M.D., Department of Internal Medicine, Harvard University School of Medicine and Massachusetts General Hospital, Boston, Mass. The course is intended to qualify the enrollee for Atomic Energy Commission licensure. Enrollment is limited to ten.

Additional information may be obtained from Frederick J. Bonte, M.D., Professor and Chairman, Department of Radiology, or John S. Chapman, M.D., Assistant Dean of Postgraduate Education, University of Texas Southwestern Medical School, 5323 Harry Hines Blvd., Dallas, Texas.

### CONFERENCE ON ELECTRICAL TECHNIQUES IN MEDICINE AND BIOLOGY

The Twelfth Annual Conference on Electrical Techniques in Medicine and Biology will be held Nov. 10-12, 1959, in the Sheraton Hotel, Philadelphia, Penna. It is sponsored by the Joint Executive Committee in Medicine and Biology, appointed by and representing the pertinent interests of the American Institute of Electrical Engineers, the Institute of Radio Engineers for its group on

Medical Electronics, and the Instrument Society of America.

Proposals for contributed papers are invited and should be submitted to Dr. L. E. Flory, RCA Laboratories, Princeton, N. J., prior to July 1, 1959. Such proposals should include résumés of 100 to 200 words and a short biographical note with company affiliation and title.

Communications on related Conference activities may be addressed to the Conference Chairman, Dr. Herman P. Schwan, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Penna.

## Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

**THERAPEUTIC RADIOLOGY: RATIONALE, TECHNIQUE, RESULTS.** By WILLIAM T. MOSS, M.D., Assistant Professor of Radiology, Northwestern University School of Medicine, Department of Radiology, Chicago, Ill.; Director, Department of Therapeutic Radiology, Chicago Wesley Memorial Hospital; Chief, Department of Therapeutic Radiology, Veterans Administration Research Hospital, Chicago, Ill. With Foreword by Lauren V. Ackerman, M.D. A volume of 402 pages, with 146 figures. Published by The C. V. Mosby Company, St. Louis, Mo., 1959. Price \$12.50.

**PROTECTION IN DIAGNOSTIC RADIOLOGY.** Edited by B. P. SONNENBLICK. A volume of 346 pages, with figures and tables. Published by Rutgers University Press, New Brunswick, N. J., 1959. Price \$7.50.

**TREATMENT OF CANCER AND ALLIED DISEASES. VOLUME III: TUMORS OF THE HEAD AND NECK BY SEVENTY AUTHORS.** Edited by GEORGE T. PACK, M.D., F.A.C.S., and IRVING M. ARIEL, M.D., F.A.C.S. A volume of 782 pages, with 1,028 figures. Published by Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, New York 16, 2nd ed., 1959. Price \$30.00.

**POST-GRADUATE TRAINING IN THE PUBLIC HEALTH ASPECTS OF NUCLEAR ENERGY.** Fourth Report of the Expert Committee on Professional and Technical Education of Medical and Auxiliary Personnel. World Health Organization Technical Report Series No. 154. A monograph of 54 pages, with 5 tables. Published by World Health Organization, Palais des Nations, Geneva, Switzerland, 1958. For sale by Columbia University Press, International Documents Service,

2960 Broadway, New York 27, N. Y. Price 60 cents.

**INTRODUCTION OF RADIATION MEDICINE INTO THE UNDERGRADUATE MEDICAL CURRICULUM.** Fifth Report of the Expert Committee on Professional and Technical Education of Medical and Auxiliary Personnel. World Health Organization Technical Report Series No. 155. A monograph of 24 pages, with 1 table. Published by World Health Organization, Palais des Nations, Geneva, Switzerland, 1958. For sale by Columbia University Press, International Documents Service, 2960 Broadway, New York 27, N. Y. Price 30 cents.

**RADIOLOGIA CLINICA DELLE CALCIFICAZIONI ENDOCRANICHE.** By Giovanni Baldini, Specialista in Radiologia e Neuropsichiatria, Clinica Neurologica dell'Università di Pavia, and Luigi Roncoroni, Specialista in Radiologia, Istituto di Radiologia dell'Università di Milano. A volume of 392 pages, with 169 figures. Published by Casa Editrice Ambrosiana, Via G. Bertacchi, 7, Milan, Italy, 1959.

## Book Reviews

**THE PNEUMOCONIOSIS PROBLEM WITH EMPHASIS ON THE ROLE OF THE RADIOLOGIST.** By EUGENE P. PENDERGRASS, M.D., Professor of Radiology, University of Pennsylvania School of Medicine, Philadelphia, Penna. A volume of 146 pages, with 53 figures. Published by Charles C Thomas, Springfield, Ill., 1958. Price \$6.75.

In 1957 Dr. Eugene Pendergrass delivered The Caldwell Lecture of the American Roentgen Ray Society, taking as his subject "Silicosis and a Few of the Other Pneumoconioses: Observations on Certain Aspects of the Problem, with Emphasis on the Role of the Radiologist." This subsequently appeared in part in the *American Journal of Roentgenology, Radium Therapy and Nuclear Medicine*. It is now published in full as an attractive monograph.

Dr. Pendergrass has made no attempt at a complete treatise on the pneumoconioses. He has sought rather to share the things that have proved helpful to him in his long experience in interpreting the shadow patterns in the roentgenograms. His conclusions are drawn from the study of 500 cases, many of which have been followed for over twenty years.

The first two chapters cover the history and types of pneumoconiosis with their inciting causes. These are followed by an extensive description of the pathogenesis, which is the basis for interpreting the radiologic manifestations. The bulk of the text is devoted to the description and classification of the roentgen features. Parallel columns presenting the roentgen appearances and the histologic observations are of special interest. Attention is drawn also

to other disease processes which may simulate pneumoconiosis. Emphasis is placed on the newer physiological studies for the estimation of disability.

This monograph will be of interest and benefit not only to radiologists but to all students of pulmonary disease.

**FRACTURES AND OTHER INJURIES.** By the Members of the Fracture Clinic of the Massachusetts General Hospital and of the Faculty of the Harvard Medical School. Edited by EDWIN F. CAVE, M.D. Drawings by Muriel McLatchie Miller. Photography by Donald Withee. A volume of 864 pages, with 612 figures, including numerous roentgenograms. Published by the Year Book Publishers, Inc., Chicago, Ill., 1958. Price \$28.00.

This impressive volume from the Massachusetts General Hospital is the work of 39 staff physicians, covering an experience of twenty-five years in the Fracture Clinic of that institution. Actually it extends far beyond the problem of fractures and dislocations to include the management of all forms of trauma. The material is well organized and the coverage is comprehensive.

Numerous excellent illustrations show the normal anatomy of the areas under consideration and the structural changes incident to trauma. The various traumatic problems are well documented with multiple progress films, including end-results. Surgical illustrations show the approaches and manipulations necessary in the presence of complicated injuries. At least one recommended procedure is described for each traumatic situation and its variations.

The management of trauma to the soft-tissues and emergency measures are considered. Dr. Stanley Wyman contributes a chapter on The Use and Abuse of X-Rays in Fractures.

This text is especially recommended as a work of reference to general practitioners of medicine and surgery and to specialists in the fields of orthopedics and radiology.

**GYNCOLOGIC RADIOGRAPHY.** By JEAN DALSACE, M.D., Chief of Sterility Service, Broca Hospital, University of Paris, Paris, and J. GARCIA-CALDÉRON, M.D., Radiologist, University of Paris School of Medicine, Paris. With a chapter on Radiography of the Breast by Charles-M. Gros, M.D., and Robert Sigrist, M.D. Foreword by I. C. Rubin, M.D. Translated by Hans Lehfeldt, M.D. A monograph of 188 pages, with 305 figures. Published by Paul B. Hoeber, Inc., Medical Book Department of Harper & Brothers, New York 16, N. Y., 1959. Price \$8.00.

In this radiographic atlas by a French gynecologist and a French radiologist, a variety of types of gynecologic disease are included. The work is primarily a collection of contrast roentgenograms—

some positive and some negative—appropriately grouped, with a page or two of pertinent text at the beginning of each group. Brief introductory chapters present some general observations, including a short discussion of contrast media, the conduct of examination, and "incidents and accidents." These are followed by chapters on the various disease processes that come within the province of the gynecologist. The abundant illustrations with their explanatory notes depict these satisfactorily.

A final chapter on Radiography of the Breast is contributed by Gros and Sigrist of Strasbourg. This contains an account of the technic, tables of radiologic signs of benign and malignant mammary conditions, and numerous reproductions of roentgenograms.

Both gynecologists and radiologists will find this work of interest.

**X-RAY DIAGNOSIS OF THE ALIMENTARY TRACT IN INFANTS AND CHILDREN.** By EDWARD B. SINGLETON, M.D., Director of Radiology, Texas Children's and St. Luke's Hospitals, Houston, Texas; Clinical Assistant Professor of Radiology, Baylor University College of Medicine; Clinical Associate Radiologist, University of Texas Post Graduate School. A volume of 352 pages, with 215 figures. Published by the Year Book Publishers, Inc., Chicago, Ill., 1959. Price \$11.00.

This book fulfills the need of the student as well as of the general radiologist for an introduction and survey of the field of gastrointestinal radiology of the infant and young child. Technics of examination are detailed and the author includes useful advice from his own experience in examining small children. Embryological development is presented simply and by organs and is correlated with anomalies at each level of the gastrointestinal tract. A particularly valuable feature is the arrangement and completeness of the bibliography. The reproductions are excellent and the paper and binding of good quality. The book is recommended to all radiologists and students.

**ORGANIC PEROXIDES IN RADIOBIOLOGY (LES PEROXYDES ORGANIQUES EN RADIOBIOLOGIE).** COLLOQUIUM ON ORGANIC PEROXIDES FORMED BY RADIATIONS AND THEIR RÔLE IN RADIOBIOLOGY, INSTITUT DU RADIUM, PARIS, 9 AND 10 JANUARY, 1957. By R. LATARJET ET AL. General Editor: M. HAÏSSINSKY. A volume of 154 pages, with numerous figures and tables. Published by Pergamon Press, Inc., 122 East 55th St., New York 22, N. Y., 1958. (Published simultaneously in France by Masson & Cie, 120, Blvd. Saint-Germain, Paris, 6<sup>e</sup>.) Price \$9.50.

This small volume is composed of a series of papers, some in French and some in English, on the organic

peroxides formed by radiations and their role in radiobiology. They were presented at a special meeting held under the auspices of the Radium Institute of Paris in 1957, the first meeting to be devoted solely to this subject. The list of contributors indicates continental and British participation only.

The material represents current thinking on this subject which is basic in character. General discussions follow a number of the papers.

**RÖNTGENANATOMIE DER NEUGEBORENE- UND SÄUGLINGSLUNGE.** By Priv.-Doz. Dr. med. habil. Z. ZSEBÖK, Budapest. With a Foreword by Prof. Dr. R. Glauner, Stuttgart. Fortschr. a.d. Geb. d. Röntgenstrahlen, Ergänzungsband 82. A volume of 160 pages, with 286 illustrations, some in color. Published by Georg Thieme Verlag, Herdweg 63, (14a) Stuttgart, Germany, 1958. Distributed in the United States and Canada by Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 75.—(\$17.85).

Dr. Zsebök, author of this comprehensive monograph, collaborated with Dr. F. Kovács, Jr., on an excellent publication dealing with the roentgen anatomy of the lung in adults, published both in French and German (reviewed in *Radiology* 63: 432, 1954). The present study seems to be the end-result of years of tedious research on the anatomy, pathology, and radiology of the lung of the newborn and infants.

The book is divided into 17 sections. After a short introduction and historical review, the methods of investigation and the material upon which the study was based are discussed. Succeeding sections deal with anthropological measurements of infant chests, roentgen technic and general observations, roentgen anatomy of the parts of the thorax, development of the lung in the fetal period, roentgen anatomy of the bronchial tree, the vascular system of the lung (with mention of the hilar region and lung markings), roentgen anatomy of the lymph system, the problem of postnatal atelectasis, the thymus, the diaphragm, and the pleura. An extensive bibliography is appended. Nearly 300 excellent illustrations accompany the text. The reproductions of chest films and anatomical preparations are of high quality, some in color.

The great volume of information gained over years by the author is well presented, and the differences between the chest of the newborn and of the adult are pointed out and stressed. For radiologists, pediatricians, and chest surgeons who are interested in this early age group, this book should be of value.

**RADIUM-ISODOSEN: DIE RADIUMDOSIERUNG IN "R."** By DR. MED. AUGUST VERHAGEN, Oberarzt an der Städt. Frauenklinik Essen (Ruhr). With a Foreword by Prof. Dr. K. Nordmeyer, Chefarzt der Städt. Frauenklinik Essen (Ruhr).

[In German and English.] A volume of 104 pages, with 39 charts, 1 photograph, and 3 tables. Published by Georg Thieme Verlag, Herdweg 63, (14a) Stuttgart, Germany, 1958. Distributed in the United States and Canada by the Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 19.50 (\$4.65).

This small booklet presents isodose curves for a number of combinations of radium tubes used mostly in gynecologic practice. Crucial isodose values were obtained by means of a Siemens "Gammameter," which is based on the change in conductivity of a cadmium-sulfide crystal under the influence of ionizing radiations. Other values were calculated and follow closely the well known Paterson-Parker figures.

While the isodose curves presented are of definite value to the gynecologist who uses the special tubes and filters (0.3 mm. platinum, brass), they do not readily apply to the standard filter of 0.5 mm. platinum generally employed in America. It is for this filter that the 8.4 r value per milligram-hour at 1 cm. distance from a point source of radium has been established. More comprehensive and more accurate isodose charts for gynecologic cases have been established recently in this country, none of which is mentioned in the meager bibliography of Verhagen's booklet.

The statement in the preface to the effect that the gynecologist should supervise his roentgen and radium therapy himself, and exclusively, might easily lead to arguments with the radiation therapist, who contends that a profound knowledge of the fundamentals of radiation physics and biology is required to apply correct radiation therapy. Another statement, in the introduction, namely, that "the argument, that isodose curves of a radium preparation have the shape of circles is not correct," is rather discouraging to one who, on the basis of sound experimentation, first called attention to this fact just forty years ago.

**INFLUENCE DES RAYONS X ET DES RADIATIONS ATOMIQUES SUR LE PATRIMOINE HÉRÉDITAIRE HUMAIN.** By Dr. MARIE-ODILE RETHORÉ. Preface by Prof. R. Turpin. A monograph of 68 pages, with numerous tables. Published by G. Doin & Cie, 8, Place de l'Odéon, Paris, 6<sup>e</sup>, France, 1957. Price, paper bound, 500 francs.

This small volume is another contribution to the much discussed problem of the genetic effects of ionizing radiations. Some of the points made by the author are as follows.

All of the radiations in the electromagnetic spectrum from gamma rays to the ultraviolet rays of 313  $\mu$  exert a mutagenic action. Cosmic rays contribute 2 to 6 rem in the first thirty years of life, although individual differences due to geographic and other factors may give a range of 1 to 50 rem.

Diagnostic radiologic procedures contribute



perhaps the greatest amount of artificial radiation to the greatest number of people. Lateral views of the lumbar spine, pelvimetry, gastrointestinal procedures, and cardiac catheterization contribute the largest doses. Atomic fallout could be a more important source to a larger segment of the population if carried to extreme.

Genetic mutations are of concern in the exposure of large segments of the population. Somatic mutations in man are related to the individual, and exposure during pregnancy, especially the first five months, and possible cancerogenic effects of radiotherapy for benign conditions, come under consideration.

Experimental studies on *Drosophila* and other organisms are cited. Data indicate that 30 r is the dose which, if given to the entire human population during the first thirty years of life, would probably double the mutation rate. This is not likely to be reached under present medical conditions, especially if all the known means of protecting the individual are utilized.

**TUMORI RARI DEL POLMONE.** By P. PIETRI, S. SALVANESCHI, A. PERACCHIA, AND G. GALLO, Clinica Chirurgica Generale dell'Università di Milano. Preface by G. Oselladore. A volume of 146 pages,

with 77 figures. Published by Casa Editrice Renzo Cortina, Viale Camillo Golgi 14, Pavia, Italy, 1957. Price L. 2,500.

Although bronchogenic carcinoma comprises by far the majority of pulmonary tumors, about 2.5 per cent of pulmonary tumors are noncarcinomatous. In seven years in the General Surgical University Clinic in Milan 491 cases of pulmonary neoplasm were observed; 479 of these were carcinomas, while 12 were of other types.

With this last group of cases as the basis for their study, the authors have reviewed the world literature and present a brief but clear study of the noncarcinomatous lung tumors, covering pulmonary adenomas, chondromatous hamartomas including multiple chondromatosis of the lung, fibromas, neurofibromas, lipomas, myomas, and hemangiomas. The last chapter of the book deals with sarcomas. Although this is a review of literature, the authors have obtained 20 figures illustrating various sarcomas. Many are reproductions of roentgenograms, all of good quality, although they are positive prints.

The coverage of the subject is remarkably exhaustive for a relatively small volume, and the book is recommended to all who have a special interest in the chest.

## In Memoriam

**WILLIAM HARVEY WHITMORE**  
1892-1959

Dr. William H. Whitmore of Norfolk, Virginia, died of coronary heart disease on Jan. 30, 1959. He had been in failing health for some months and had retired from active practice on Aug. 31, 1958.

Dr. Whitmore was born in Lynchburg, Virginia, and spent his early life there. He received his M.D. degree from the University of Virginia in 1916. Following this he served in World War I, first in the Army and later in the Navy. He was injured in action in 1918 and was awarded the Purple Heart. He rose to the rank of Captain and for some years, including those of World War II, he was roentgenologist at the U. S. Naval Hospital at Portsmouth, Virginia.

Having retired from the Navy in 1938, Dr. Whitmore entered practice with Dr. C. W. Eley in Norfolk. He was recalled to active duty in November 1940, and following service in World War II was again placed on inactive duty. After serving as radiologist at De Paul Hospital, Norfolk, he reentered private practice in 1951. From 1955 to 1958 he was associated with Dr. P. B. Parsons.

Dr. Whitmore was a member of the Norfolk County Medical Society, the Virginia State Medical Society, the American Medical Association, the Radiological Society of North America, the American Roentgen Ray Society, and the Virginia Radiological

Society, of which he was a past-president. He was a fellow of the American College of Radiology.

Dr. Whitmore is survived by his wife, Harriet, two daughters, Mrs. Jane W. Whitmore of Virginia Beach and Mrs. Mary Ellen Cheek of Dallas, Texas, and a son, William H. Whitmore, Jr., M.D., who is in the practice of medicine in Norfolk, Virginia.

A Resolution passed by the Norfolk County Medical Society, from which the above facts were taken, concludes:

"Whereas the Norfolk County Medical Society has lost a beloved member, whose ability and integrity were recognized by his associates in Radiology as well as his medical colleagues,

"Whereas the high degree of excellence which he exacted from his associates was none the less imposed upon himself.

"Whereas his quickness to champion a cause in which he believed, even if unpopular, and his readiness to accept defeat graciously were qualities which endeared him to his colleagues,

"Whereas the above facts are in brief, a summary of that member's life,

Therefore, be it resolved that these words become a part of the record of The Norfolk County Medical Society. . ."



## ABSTRACTS OF CURRENT LITERATURE

### ROENTGEN DIAGNOSIS

#### The Head and Neck

- JAEGER, RUDOLPH. Vascular Disorders of the Brain: Their Diagnosis and Neurosurgical Treatment..... 769
- RISCHBIETH, R. H. C., AND BULL, J. W. D. The Significance of Enlargement of the Superior Orbital (Sphenoidal) Fissure..... 769
- WICKBOM, INGMAR, AND STATTIN, STURE. Roentgen Examination of Intracranial Meningiomas 770
- ARSENI, CONSTANTIN. Tumors of the Basal Ganglia: Their Surgical Treatment..... 770
- LÖFGREN, F. OLOV. Vertebral Angiography in the Diagnosis of Tumours in the Pineal Region..... 771
- KLAUS, EDMUND. Contribution to the Pneumographic Diagnosis of Tumors of the Pineal Body..... 771
- LAINE, E. ET AL. Fractional Ventriculography with the Head Down. A Diagnostic Method for Tumors of the Posterior Fossa and the Cerebral Trunk..... 771
- SALTZMAN, GEORG-FREDRIK. Roentgenologic Changes in Cerebral Sarcoidosis..... 772
- LORBER, JOHN. Intracranial Calcification Following Tuberculous Meningitis in Children... 772
- LORBER, JOHN. Massive Disseminated Intracranial Calcification Following "Serous Tuberculous Meningitis"..... 772
- POOL, J. LAWRENCE, ET AL. Cerebral Vasospasm—Clinical and Experimental Evidence. 772
- WIEDENMANN, O., AND LEUCHS, K. H. Encephalography with the Image Intensifier..... 772
- BONTE, G., ET AL. Vertebral Angiography by Retrograde Femoral Catheterization..... 773
- DI CHIRO, GIOVANNI. Carotid Angiography in Eight Cases of Unilateral Ophthalmoplegia... 773
- KÄGSTRÖM, ERIK, ET AL. Changes in Cerebral Circulation During Carotid Angiography with Sodium Acetrizate (Triurol) and Sodium Diatrizate (Hypaque). An Experimental Study..... 773
- ROVIRA, M., ET AL. The Collateral Circulation in Thrombosis of the Internal Carotid Artery and Its Branches..... 773
- LINDGREN, PERCY, AND TÖRNELL, GUNNAR. Blood Pressure and Heart Rate Responses in Carotid Angiography with Sodium Acetrizate (Triurol). An Experimental Study in Cats..... 774
- JIROUT, JAN. Pneumographic Investigation of the Cervical Spine..... 774
- LEWIT, K. Combination of Encephalography with Small Amounts of Air and Myelography of the Cervical Spinal Canal..... 774
- SCHOBINGER, ROBERT. Spasm of the Cricopharyngeal Muscle as Cause of Dysphagia After Total Laryngectomy..... 774

- BURKE, EDWARD NEWELL, AND GOLDEN, J. LAURENCE. External Ventricular Laryngocoele..... 775
- ROSSMANN, BÉLA. A Simple Method for Taking Roentgenograms of an Infant's Ear..... 775
- ROSSMANN, BÉLA. Roentgenograms of Normal Infant Ears..... 775
- ROSSMANN, BÉLA. Roentgen Anatomy of the Infant Ear..... 775

#### The Chest

- CAREY, JOHN M., AND GREER, ALLEN E. Bronchogenic Carcinoma Complicating Pulmonary Tuberculosis: A Report of Eight Cases and a Review of 140 Cases Since 1932..... 776
- BUECHNER, HOWARD A., AND THOMPSON, JORDAN. Circumscribed Intrapulmonary Hematoma Presenting as a "Coin Lesion"..... 776
- LEMAHIEU, S. F., ET AL. Pulmonary Manifestations of Choriocarcinoma..... 777
- ROUJEAU, J., AND ROSE, Y. On Certain Pulmonary Talcomas..... 777
- SROUJI, MAURICE, ET AL. Hydatid Cyst of the Lung with Bronchographic Evaluation of Treatment by Internal Suture of the Pericyst..... 777
- TAPIE, J., ET AL. Bronchopulmonary Aspergillosis with Alternating Bullae and Parenchymatous Consolidation..... 777
- LEMERCIER, J. P., AND MANOUVRIER. Bronchiectatic Aspergilloma and Bronchial Aspergillosis 777
- PENDERGRASS, EUGENE P. Silicosis and a Few of the Other Pneumoconioses: Observations on Certain Aspects of the Problem, with Emphasis on the Role of the Radiologist. Caldwell Lecture, 1957..... 778
- BAKER, GERALD L., AND HEUBLEIN, GILBERT W. Postoperative Aspiration Pneumonitis..... 779
- SCHULZE, W. Roentgenologic Studies Following Aspiration of Metallic Mercury..... 779
- WINSLOW, WILLIAM A., ET AL. Pleuritis in Systemic Lupus Erythematosus: Its Importance as an Early Manifestation in Diagnosis. 779
- HERLITZKA, ALFRED J., AND GALE, JOSEPH W. Tumors and Cysts of the Mediastinum. Survey of One Hundred Seventy-Four Mediastinal Tumors Treated Surgically During the Past Eighteen Years at the University of Wisconsin Hospitals..... 780
- ROSEFF, IRWIN, ET AL. Lipothymoma Simulating Cardiomegaly. Case Report..... 780

#### The Heart and Blood Vessels

- COATES, E. OSBORNE, JR., AND DRAKE, ELLET H. Myxoma of the Right Atrium, with Variable Right-to-Left Shunt: Clinical and Physiologic Observations and Report of a Case with Successful Operative Removal..... 781
- SOLOFF, LOUIS A., ET AL. Double Mitral Valve... 781

- LINKO, EINO, AND SYSIMETSÄ, ERKKI. Clinical and Radiological Aspects of Calcification of the Mitral Region..... 781
- KILLIP, THOMAS, III, AND LUKAS, DANIEL S. Tricuspid Stenosis. Clinical Features in 12 Cases..... 782
- MONK, IAN, ET AL. A Preliminary Report on a Study of Experimentally Produced Tricuspid and Mitral Valve Regurgitation..... 782
- LACONI, ANTONELLO. The Dynamics of the Left Ventricular Border in Chronic Constrictive Pericarditis: An Analytic Roentgenkymographic Study with Remarks on the "Flat Top and V" Electrocardiographic Pattern... 783
- SÖVÉNYI, E., ET AL. Occlusion of the Main Branches of the Pulmonary Artery without Formation of an Infarct, with Development of a Subacute Cor Pulmonale..... 783
- GUNTHEROTH, WARREN G., ET AL. Transposition of the Pulmonary Veins..... 783
- LEIGHT, LEONARD, AND DAVIS, LAWRENCE A. The Relation of the Aortic Root to the Ventricular Septum in Tetralogy of Fallot..... 784
- JOHNSON, A. M., AND LOGAN, WILLIAM D. Coronary Artery Catheterization During Thoracic Aortography..... 784
- FINEBERG, CHARLES, ET AL. Gangrene of the Large Intestine and Ovaries after Translumbar Aortography. Report of a Case..... 784
- The Breast**
- INGLEBY, HELEN, ET AL. A Roentgenographic Study of the Growth Rate of 6 Early Cancers of the Breast..... 785
- The Digestive System**
- MACMAHON, H. EDWARD, ET AL. Pathology of a Lower Esophageal Ring; Report of a Case, with Autopsy, Observed for Nine Years..... 785
- FRIEDMAN, A. I. Peptic Esophagitis Simulating the "Postcholecystectomy Syndrome"..... 785
- BOTHWELL, T. H., AND THOMAS, R. GLYN. Sideropenic Dysphagia..... 785
- COHN, ISIDORE, JR., AND SARTIN, JACK. Giant Gastric Ulcers..... 786
- BASSÖE, HANS H. Multiple Syphilitic Ulcers of the Stomach and Duodenum. A Case with Unusual Luetic Manifestations..... 786
- MEDHURST, G. A. Gastric Leiomyoma..... 786
- KOCH, WALTER, ET AL. Eosinophilic Granuloma of the Stomach. Report of a Case..... 786
- NELSON, ROBERT S., AND SALVADOR, DIONISIO S. J. Pseudotumors of Gastric Antrum in Pernicious Anemia. Report of a Case..... 786
- MYBURGH, J. A. Intussusception in the Adult... 787
- BOLDERO, JOHN L. Calculi in a Meckel's Diverticulum..... 787
- HOCH, A. P., AND FOSTER, S. E. Use of a New Micronized Barium (Barotrast) in Roentgen Examinations, with Special Consideration of Double-Contrast Study of the Colon..... 787
- DONAHUE, JOHN K., ET AL. Significance of Fluid Levels in X-Ray Films of the Abdomen..... 788
- GAEBEL, EVA, AND TESCHENDORF, W. Roentgen Findings in Cholecystitis..... 788
- COHN, EDWIN M., AND SKLAROFF, DAVID M. A Review of the Current Status of Nonoperative Cholecystoangiography..... 788
- JONES, MALCOLM D., ET AL. Intravenous Cholangiography in Children with Fibrocystic Disease of the Pancreas. A Pilot Study..... 788
- The Musculoskeletal System**
- BARRIE, HERBERT, ET AL. Multiple Epiphyseal Dysplasia..... 788
- HENRIQUES, C. Q. Osteomyelitis as a Complication in Urology with Special Reference to the Paravertebral Venous Plexus..... 789
- WEISSMANN, GERALD. Scleroderma Associated with Osteopoikilosis..... 789
- LEPKOVITS, AARON M., AND THOMAS, J. R. Rheumatoid Spondylitis: Manifestations and Management..... 790
- ACKERMANN, W., AND SCHWARZ, G. S. Nonneoplastic Sclerosis in Vertebral Bodies..... 790
- PATTERSON, HOWARD A., AND BYERLY, GRIMES. Esophageal Obstruction Due to Lesions of the Cervical Spine..... 790
- WALK, L. Slight Myelographic Deformities in Sciatica..... 791
- KOHOUT, J. Epidural Pneumomyelography..... 791
- MENDL, KARL, AND EVANS, CYRIL J. Cyst-Like and Cystic Lesions of the Rib with Special Reference to Their Radiological Differential Diagnosis Based on Five Cases..... 791
- DEÁK, P. Concerning Acro-Osteosclerosis..... 791
- Gynecology and Obstetrics**
- YOUNGSTROM, KARL A. Salpingography: Study of Use of Diatrizoate Sodium (Hypaque).... 792
- TOPOLANSKI-SIERRA, RICARDO. Pelvic Phlebography..... 792
- STEWART, A. M. The Importance of the Radiographic Demonstration of Free Gas in the Fetus in the Diagnosis of Intra-Uterine Death..... 792
- CANOV, NESTOR R. Localization of the Placenta in Suspected Cases of Placenta Previa with the Use of Radio-Active Isotopes (RIHSA)... 792
- The Genitourinary System**
- TAYLOR, J. N., AND GENTERS, K. W. Clinical Evaluation of Two Recently Developed Urographic Media..... 793
- BRETLAND, P. M. Relationship of Bladder Shadow to Bladder Volume on Excretion Urography..... 973
- The Endocrine Glands**
- SPENCE, A. W. The Radiology of Endocrine Disorders. A Symposium. I. The Diagnostic Value of Radiology in Endocrine Disorders..... 793

- ASTLEY, R. The Radiology of Endocrine Disorders. A Symposium. II. Hypothyroidism in Children..... 794
- LAWS, J. W. The Radiology of Endocrine Disorders. A Symposium. III. Radiology of the Suprarenal Glands..... 794

#### Miscellaneous

- WOLF, H. G. Contribution to the Diagnosis and Etiology of Spontaneous Pneumoperitoneum in the Newborn..... 794
- JACOBSEN, H. H., AND HYLLESTED, K. Localized Atrophy of the Spinal Cord..... 795

#### Technic

- BROWN, JOHN R. A New Technique for the Localization of Radiopaque Foreign Bodies... 795
- COPE, CONSTANTIN. Simple Method for the Introduction of Large-Gauge Plastic Catheters..... 795

#### RADIOTHERAPY

- MOWATT, KEITH S., ET AL. Post-operative Radiotherapy of Mammary Carcinomata... 795
- WEED, JOHN C. Combined Irradiation and Surgical Treatment for Carcinoma of the Cervix. Analysis of 79 Cases of Wertheim Hysterectomy and Pelvic Lymphadenectomy 796
- BROWNE, F. J. A Case of Chorionepithelioma of the Uterus with Pulmonary Metastases Cured by Operation and X-Rays..... 796
- COCCHI, UMBERTO. Tumors in Childhood..... 796
- BRUSTAD, TOR, AND HENRIKSEN, THORMOD. Glass Dosimetry of Soft X-Rays..... 797

#### RADIOISOTOPES

- ALLEN, HERBERT C., JR., ET AL. Diagnosis of Intraocular Neoplasms Using Radioactive Phosphorus. Clinical and Pathological Aspects..... 797
- FOUNTAIN, JAMES R. Haemorrhagic Thrombocythaemia. Report of Two Cases Treated with Radioactive Phosphorus..... 797
- LAWRENCE, JOHN H., AND DONALD, WILLIAM G., JR. Giant Follicular Lymphoblastoma: Its Treatment with Radioisotopes..... 798
- COLE, JACK W., AND MATTHEWS, LEROY M. Distribution of Radioactive Tryptophan in a Patient with Metastatic Carcinoid..... 798

- NYBERG, WOLMAR, ET AL. Urinary Excretion of Radiovitamin B<sub>12</sub> in Carriers of Diphyllorhynchium latum..... 798
- EPP, E. R., ET AL. Ionization Build-up in Upper Respiratory Air Passages During Teletherapy with Cobalt 60 Radiation..... 799
- STONER, RICHARD D., AND HALE, WILLIAM M. The Depressant Effect of Continuous Cobalt-60 Radiation on the Secondary Tetanus Antitoxin Response in Mice..... 799
- HALE, WILLIAM M., AND STONER, RICHARD D. Enhancing Effect of Continuous Cobalt-60 Gamma Radiation on Susceptibility to Anaphylactic Shock in Mice..... 799
- VAN DILLA, M. A., ET AL. Radium (Ra<sup>226</sup>) and Radon (Em<sup>222</sup>) Metabolism in Dogs..... 799
- HORST, WOLFGANG, ET AL. An Electronic Method for Improvement of Contrast Scintigraphy of the Thyroid, Liver, etc..... 800

#### RADIATION EFFECTS

- HODGES, PAUL C., ET AL. A Testicular Shield... 800
- FOMON, JOHN J., ET AL. Single Dosage X-Ray Radiation to the Lung and Posterior Mediastinum Through the Open Chest. I. Results in Dogs Receiving Dosage between 6,000 and 15,000 r..... 800
- JACKSON, KENNETH L., ET AL. Electrolyte Excretion in the Rat after Severe Intestinal Damage by X-Irradiation..... 801
- FLIEDNER, THEODOR M. Marrow-Cell Suspensions in Bone-Marrow Damage Due to Radiation..... 801
- BRYAN, JOHN H. D., AND GOWEN, JOHN W. The Effects of 2,560 r of X-Rays on Spermatogenesis in the Mouse..... 801
- SCHERER, EBERHARD, AND VOGELL, WOLRAD. Examinations of Radiation Effects on Liver, Spleen, and Kidney with an Electron Microscope..... 802
- JOLLES, B., AND GREENING, S. G. Studies of Indirect Radiation Effects with Skin Grafting Experiments and Colorimetric Estimations of Erythema..... 802
- RUGH, ROBERTS. The So-Called "Recovery" Phenomenon and "Protection" Against X-Irradiation at the Cellular Level..... 802
- PALMIERI, GIAN GIUSEPPE. The Effect of Revelators (Detectors) in Radiobiology and Radiotherapy..... 802

## ROENTGEN DIAGNOSIS

## THE HEAD AND NECK

**Vascular Disorders of the Brain: Their Diagnosis and Neurosurgical Treatment.** Rudolph Jaeger. Pennsylvania M. J. 61: 758-763, June 1958. (Jefferson Medical College, Philadelphia, Penna.)

Vascular accidents involving the cranial arteries are common and, in the presence of symptoms suggesting a stroke syndrome, it is mandatory that a precise diagnosis of the pathologic etiology and location of the lesion be made. This is possible with minimal risk through the neurosurgical maneuvers involved in cerebral angiography.

The technic employed at the Jefferson Medical College, from which this report comes, calls for the almost instantaneous injection of 4 to 8 c.c. of radiopaque fluid into the carotid artery in the neck and simultaneous exposure of the head and neck. To facilitate this maneuver and provide greater flexibility in positioning the head, the vessel is pierced with a needle, through which is threaded a tiny hollow tube of polyethylene 8 inches long. The needle is then withdrawn from over the tubing, one end of which remains inside the artery while the other is connected to a syringe by means of which the fluid is forcibly introduced as the exposures are made. Four to six films can be obtained in sequence at one-second intervals, each showing a different part of the blood-vessel system of the brain. Deviation from the well known normal pattern is demonstrated either by an abrupt interruption of the column of blood or by a widening of the blood vessel by weakening and giving way of its wall at some tiny local point. Hardening of the artery wall, emboli, aneurysms, brain tumors, blood clots between skull and brain, and many other cerebral disorders—not necessarily of the vessels—can be accurately diagnosed by this method.

A review of 200 cerebral arteriograms obtained in this manner in eighteen months, revealed only 1 death, and that in a comatose, completely hemiplegic patient who died from malignant brain tumor twelve hours after the examination.

Accurate diagnosis leads to effective therapy. While many lesions may be best treated by medical methods, a majority of them require definitive surgery, with a good chance of curing the disorder. This is particularly true of intracranial blood clots and aneurysms of the brain. It is no longer permissible to consider a stuporous, paralyzed patient incurable.

Eight roentgenograms; 1 diagram.

**The Significance of Enlargement of the Superior Orbital (Sphenoidal) Fissure.** R. H. C. Rischbieth and J. W. D. Bull. Brit. J. Radiol. 31: 125-135, March 1958. (National Hospital, Queen Square, London, England)

The authors have made a survey of pathological conditions occurring in the region of the superior orbital fissure and the cavernous sinus, which might be expected to cause widening of the fissure, and to ascertain the frequency with which this widening actually takes place. The technics employed for the roentgen demonstration of the superior orbital fissure are described. The material studied was from the National Hospital, Queen Square, and the Atkinson Morley Hospital, London.

**Infracaloid Aneurysms** (23 cases): Infracaloid aneurysms are relatively uncommon, only 13 out of 275

successive cases of intracranial aneurysm seen at the Atkinson Morley Hospital being in this situation. Of the 23 cases of infracaloid aneurysm in the authors' series, definite detectable erosion of the greater wing of the sphenoid bone with obvious widening of the superior orbital fissure was demonstrated radiographically in 17 (74 per cent). Erosion of the inferior border of the lesser wing of the sphenoid was seen in 7 of these 17 cases. In another case, though there was no demonstrable widening of the superior orbital fissure, there was definite erosion of the lesser wing of the sphenoid with decalcification of the inferolateral wall of the optic canal.

Special projections for visualization of the optic canals were available in 10 cases only; in 2 the canals were normal and in the remaining 8 there was erosion of the inferolateral wall of varying, though always obvious, degree.

Erosion of the bone surrounding the pituitary fossa was an almost constant feature. The posterior clinoid processes and dorsum sellae were severely decalcified and eroded in 14 cases, slightly but definitely in another 7 cases, and normal in the remaining 2. The ipsilateral anterior clinoid process was eroded, elevated, or destroyed in 20 cases and normal in 3. In 3 cases there was marked erosion of the floor of the pituitary fossa as seen in a lateral radiograph, the appearance being not dissimilar to that produced by an intrasellar space-occupying lesion. The floor of the middle fossa was seen to be definitely eroded in 1 case in the basal view.

Calcification of a portion of the aneurysmal sac was visible in 8 cases (38 per cent). In 1 patient with an eighteen-year history, there was an almost complete ring surrounding the aneurysm; in another with a seventeen-year history a large proportion of the aneurysmal wall was outlined by calcium. In the remainder calcification was very much more limited in extent.

In 22 cases angiographic evidence of the aneurysm was obtained. In the remaining case, spontaneous thrombosis of the internal carotid at a level just above the common carotid bifurcation rendered arteriographic proof of the aneurysm impossible, though its grossly calcified wall left little doubt about the diagnosis.

**Carotico-Cavernous Fistula** (3 cases): Three cases of apparently spontaneous carotico-cavernous fistula formation, presumably due to rupture of an intracavernous aneurysm, were studied. In 1 of the cases there was definite widening of the fissure eight months after the onset of symptoms. The other 2 cases, of five and eight weeks duration, respectively, did not show this sign.

**Pituitary Tumor** (191 cases): Of the 191 cases of proved pituitary tumor reviewed, 8 (5 per cent) showed definite widening of the superior orbital fissure. Lateral radiographs revealed the pituitary fossa to be greatly enlarged in 4 of these cases and only slightly enlarged in the other 4. The widening of the superior orbital fissure was unilateral in 7 cases and bilateral in the eighth, but only 3 patients exhibited oculomotor palsies with some degree of fifth nerve involvement.

**Meningioma** (102 cases): Four of the 102 cases (4 per cent) of pterional, sphenoid wing, and middle fossa meningiomas studied were found to show widening of the fissure (as opposed to the more usual bony sclerosis adjacent to the site of tumor origin). Three of these cases, however, exhibited additional radiological abnormalities, giving an appearance distinguishable from



that in aneurysm. In 1 there was sclerosis around the optic canals and both greater and lesser wings of the sphenoid; in another the optic canal was markedly compressed, and in the third the floor of the middle fossa was extensively destroyed, and some calcification was visible within the tumor.

**Orbital Tumors (38 cases):** Thirty-eight cases with a presumptive diagnosis of orbital tumor were surveyed; in 28 of these histologic proof of the diagnosis was available. Marked widening of the superior orbital fissure was demonstrated in 5 of the 28 proved cases (about 20 per cent). In 2 of these there was a dumbbell neurofibroma with extensions within both the orbital and cranial cavities. In another case there was an orbital granuloma which after eighteen years became associated with ipsilateral temporal lobe epilepsy and a chiasmic visual field defect. The fourth case was one of plasmacell myeloma which presented at first in one orbit and then in the other, producing progressive widening on either side. The fifth was a case of orbital reticulosarcoma.

**Chordoma (3 cases):** In 1 of the 3 cases of chordoma studied there was extensive destruction of the greater wing of the sphenoid, as well as gross destruction of the floor of the middle fossa.

The authors conclude that, while erosion of the lesser wing of the sphenoid is highly suggestive of the presence of an intracranial aneurysm, it is by no means pathognomonic. Cases of pituitary tumor, sphenoidal wing meningioma, neurofibroma, and chordoma all showed this feature, as well as the case of orbital reticulosis in which the clinical picture closely mimicked that of aneurysm. The relationship between the clinical syndrome produced, the size of the aneurysm, the length of the history, and the amount of bone destruction is only approximate, but cases with large aneurysms, long histories, and visual deterioration tended to show more definite sphenoidal fissure enlargement.

Twenty-one roentgenograms; 16 tracings of roentgenograms; 1 photograph; 1 table.

#### Roentgen Examination of Intracranial Meningiomas.

Ingmar Wickbom and Sture Stattin. *Acta radiol.* 50: 175-186, July-August 1958. (Roentgendiagnostic Department III, Sahlgrenska Sjukhuset, Gothenburg, Sweden)

The examination of intracranial meningiomas by means of conventional roentgenography, angiography, and pneumography is considered with special reference to 80 verified cases.

**Conventional Radiography:** Meningiomas may produce a worm-eaten appearance on the roentgenogram caused by the growth of the tumor along the tiny vessels which penetrate the vault and sclerosis of the bone between these channels. If the tumor extends to the outside of the vault, perpendicular striations may be seen. Wide and tortuous vascular grooves in many cases run to and from this area. In many cases reaction in the form of sclerosis occurs where the meningioma is attached to the bone. Local sclerosis in the greater or lesser wing of the sphenoid is of great significance and may be considered diagnostic.

Pure osteolytic lesions are unusual in meningiomas and may be difficult to differentiate from other destructive processes such as eosinophilic granulomas, myelomas, metastatic tumors, xanthomatosis, etc. If the destruction is localized mainly to the inner table of the

vault, however, it is most certainly caused by a meningioma.

Calcifications were seen in only 5 cases in this series. Their appearance is usually not typical of meningioma. Tightly packed granular calcifications are, however, said to be characteristic of suprasellar meningiomas and may be present also in meningiomas of the posterior fossa.

**Angiography:** Tumor vessels with a tortuous course and a regular lumen without local dilatations or constrictions are typical of meningiomas. The vessels are regularly arranged and penetrate the tumor in a broom-like fashion from its attachment, or like spokes in a wheel from an artery running along the surface. A "blush" or filling of the tumor has also in most cases been considered diagnostic. Demonstration of a blood supply from the external carotid artery is the most certain means of diagnosing a meningioma. The best method of doing this is to inject the contrast medium directly into the external carotid artery.

Parasagittal meningiomas often infiltrate the superior longitudinal sinus. If the contrast-filling of this sinus ceases abruptly at the level of the tumor, the diagnosis of a meningioma infiltrating the sinus may be made. The displacement of the vessels by meningioma is more characteristic than that seen in a cerebral tumor with more infiltrating manner of growth. In meningiomas the arteries are displaced in arches around the tumor, sometimes forming, as it were, a bowl in which the tumor appears to lie. The arteries surrounding the tumor are often somewhat hypertrophic even if no real tumor vessels can be demonstrated. Gliomas, on the other hand, usually infiltrate between the vessels and stretch them.

**Pneumography:** Examination of the subarachnoid space is of the utmost importance for determining the true nature of the lesion. If the tumor can be shown more or less completely outlined by gas in the subarachnoid space, this means that it is extracerebral. Extracerebral tumors are, with the exception of acoustic and pituitary tumors, practically always meningiomas. Intraventricular location of a tumor may as a rule be easily demonstrated by pneumography.

The authors' observations in their of 80 cases indicate that it should be possible in most instances to make a correct preoperative diagnosis of meningiomas by combining the results of the three methods described above. This is true especially of meningiomas arising from the convexity of the skull, from the olfactory groove, and from the sphenoidal ridge.

Other tumors sometimes produce angiographic appearances similar to those encountered in meningiomas. In some 15 cases comprising mainly glioblastomas and tumor metastases, the suggestion of a meningioma was made. The tumors have in these cases been fairly well defined and tumor vessels of atypical appearance or signs of a more or less complete blush were seen in many of them.

Twenty-one roentgenograms; 1 table.

THEODORE E. KEATS, M.D.  
University of Missouri

**Tumors of the Basal Ganglia: Their Surgical Treatment.** Constantin Arseni. *Arch. Neurol. & Psychiat.* 80: 18-24, July 1958. (State Hospital No. 9, Sos. Bereni, Bucharest 10, Rumania)

This paper records experience with 50 primary tumors of the basal ganglia collected during 2,000 surgical in-



interventions for brain tumor. Forty-six of the tumors were glial in origin and 4 were tuberculomas.

The plain films showed signs of intracranial hypertension in 70 per cent of the cases. Characteristically the ventriculograms show: (1) little or no displacement of the interventricular septum, (2) absence of filling of the third ventricle and of the descending part of the ipsilateral temporal horn, (3) dilatation of the ventricle opposite the tumor and displacement of the ventricle on the same side as the tumor. In the lateral view the ventricular displacement may precisely outline the tumor.

Ten of the patients in the author's series died before therapy could be instituted. Twenty-seven were given palliative therapy, consisting of a subtemporal decompression followed by irradiation. All died within a few months. In 13 cases an attempt at total excision was made. Nine of the 13 patients were alive at the time of this account; 2 of these successful cases are reported.

The authors suggest that a more radical surgical attack on tumors originating in the basal ganglia may salvage a percentage of cases formerly believed incurable.

Two roentgenograms; 1 photograph; 2 drawings.

MAJOR MARTIN A. THOMAS, M.C.  
McDill AFB, Tampa, Fla.

**Vertebral Angiography in the Diagnosis of Tumours in the Pineal Region.** F. Olov Löfgren. *Acta radiol.* 50: 108-124, July-August 1958. (Roentgendagnostic Department, University Hospital, Lund, Sweden)

The author presents a description of the vasculature of the pineal region based upon 100 normal angiographic studies and an analysis of 21 cases of tumor in the pineal region and 6 tumors in the adjacent part of the thalamus. The arteries of most interest in the diagnosis of pineal region tumors are the posterior choroid arteries. The veins of particular interest are the internal cerebral, the basilar, and the great cerebral.

Tumors in the pineal region, if large enough, may be diagnosed by vertebral angiography. The changes in the vascular pattern are best seen in the lateral view. Such tumors displace arteries as well as veins; both posterior choroid arteries are pushed upward and backward, the curve of the posterior choroid artery is increased, and the internal cerebral veins are displaced upward and backward. If the displacement is slight, the posterior parts of the internal cerebral veins are straightened so that an angle develops between the internal cerebral vein and the great cerebral vein in place of the normal S-shaped curve. If the displacement is more marked, the internal cerebral veins are lifted in a curve convex upward and backward, and the angle with the great cerebral vein then becomes acute. The displacement of the veins appears earlier than that of the arteries, and a straightening of the internal cerebral veins may sometimes be demonstrated in the absence of any arterial displacement.

Tumors in the posterior part of the thalamus may produce displacement of the posterior choroid artery similar to that seen in pineal tumors; thalamic tumors, however, displace this artery only on the side involved by the tumor, the pattern on the other side being normal. Pineal tumors push the internal cerebral veins upward in the same way as the arteries; tumors of the thalamus, on the other hand, displace these veins in a curve convex downward, or only straighten them. Both pineal tumors and thalamic

tumors sometimes have pathologic vessels and show tumor staining.

If the tumor contains pathologic vessels and/or becomes contrast-filled it may be a teratoma (in children) or a glioblastoma (in adults). Calcification of the pineal body in children strongly suggests a tumor in the pineal region, especially if the calcification is extensive. The distance between the pineal calcification and the internal cerebral veins may be increased; if it exceeds 3 mm., a tumor should be suspected; if the distance is over 6 mm., the diagnosis may be made with confidence.

In the present investigation 13 of the 21 tumors in the pineal region could be diagnosed by vertebral angiography, and this method is considered a valuable one for examining the pineal region and adjacent part of the thalamus. Vertebral angiography and pneumography together permit a precise determination of the essential features of tumors in this area.

Sixteen roentgenograms; 2 photographs; 4 diagrams.

THEODORE E. KEATS, M.D.  
University of Missouri

**Contribution to the Pneumographic Diagnosis of Tumors of the Pineal Body.** Edmund Klaus. *Acta radiol.* 50: 12-17, July-August 1958. (In German) (Neurologische Klinik der Palacký Universität, Olomouc, Czechoslovakia)

The pneumographic picture of tumors of the pineal region, as of the pineal itself, is characteristic: a smooth, ventrally convex filling defect in the posterior contour of the third ventricle, obliteration of the suprapineal recess, possibly the formation of a pseudorecess, ventral displacement of the third ventricle, basal displacement and early obliteration of the supratentorial segment of the aqueduct, dilatation of the lateral ventricles and the remainder of the third ventricle, and finally an increased distance between the posterior part of the third ventricle and the calcification in the pineal.

To this radiologic complex, the author adds another item: the distance between the third ventricle and the cisterna ambiens. Normally this ranges from 17 to 14 mm.; it is decreased when the third ventricle is dilated, and is increased beyond 15 mm. in the presence of tumors of the pineal and pineal region.

The author considers this sign practical, especially in the diagnosis of small tumors before the aqueduct is occluded. It is particularly important in those occasional patients in whom the posterior wall of the third ventricle mimics very closely a filling defect.

Two roentgenograms; 1 diagram.

CHRISTIAN V. CIMMINO, M.D.  
Fredericksburg, Va.

**Fractional Ventriculography with the Head Down. A Diagnostic Method for Tumors of the Posterior Fossa and the Cerebral Trunk.** E. Laine, G. Riff, J. M. Delandtsheer, and P. Galibert. *Acta radiol.* 50: 48-51, July-August 1958. (In French) (Centre Hospitalier Régional de Lille, France)

The indications for ventriculography have become progressively limited with the development of carotid angiography and fractional encephalography for the diagnosis of supratentorial as well as infratentorial tumors. When the tumor originates in the cerebellum, however, or the wall of the fourth ventricle, and causes complete obliteration of the ventricle or the cerebral aqueduct, lumbar encephalography is inadequate, since it does not permit visualization of the aqueduct or the

third ventricle. Vertebral angiography is also limited in the diagnostic data it can provide.

In the usual method of ventriculography the aqueduct and the major region of interest in the third ventricle, namely, its floor and roof, are partially masked by filling of the lateral ventricles, especially the temporal horns. The authors have devised a ventriculographic method that avoids filling of the lateral ventricles. The examination is done with the patient erect, with the head down. By proper insertion of the trocar near the foramen of Monro, and proper tilting of the head, the third ventricle and its aqueduct can be filled selectively with small amounts of gas, with radiographic control.

CHRISTIAN V. CIMMINO, M.D.  
Fredericksburg, Va.

**Roentgenologic Changes in Cerebral Sarcoidosis.** Georg-Fredrik Saltzman. *Acta radiol.* 50: 235-241, July-August 1958. (Serafimerlasarettet, Stockholm, Sweden)

Five cases of intracranial sarcoid granulomas are reported. The location varied, but all produced signs of an expanding intracranial process. Angiography, performed in 2 cases, demonstrated poor vascularization of the lesion. Following regression of the granulomas under conservative therapy, localized cerebral atrophy became apparent.

Sixteen roentgenograms. JOHN C. POWERS, M.D.  
St. Vincent's Hospital, N. Y.

**Intracranial Calcification Following Tuberculous Meningitis in Children.** John Lorber. *Am. Rev. Tuberc.* 78: 38-61, July 1958. See also *Acta radiol.* 50: 204-210, July-August 1958. (University of Sheffield Children's Hospital, Sheffield 10, England)

Calcification in intracranial tuberculous lesions was rare before effective drug therapy was available, but since the introduction of streptomycin it has been found frequently. This paper reviews 130 cases of tuberculous meningitis in children developing between September 1947 and June 30, 1955. Roentgenograms of the skull were taken on admission and at least once at an interval of twenty-one months or more following the onset of the disease. Of the original 130 patients, 120 are alive and all but one are comparatively free of active intracranial infection. Up to November 1957 calcification was found on roentgenograms of the skull in 48.4 per cent of the children. It appeared fifteen to twenty-four months after admission in one-fourth of the patients, in twenty-five to thirty-six months in approximately one-half, and in thirty-seven months or more in approximately one-fourth. In no instance did the calcium disappear during the period of study.

Calcification occurred in the basal meninges and within the brain substance. Meningeal calcification was seen in 49 patients and intracerebral calcification in 17. The roentgenographic appearance of meningeal calcification was that of clusters or plaques of amorphous density in the region of the sella turcica. In some patients it was noted in the cisterna ambiens surrounding the brain stem. It was often bilateral and usually in or near the midline. Rarely it was found in the sylvian fissure. The intracerebral deposits tended to be small and to consist of multiple small foci. In only 2 patients did local foci exceed 1 cm. in diameter. The calcification was somewhat more common in patients with severe disease than in those without neurological sequelae.

Calcification appeared to occur less frequently in

patients treated with isoniazid than in those treated with streptomycin alone or with streptomycin and PAS. The use of intrathecal tuberculin and streptokinase also reduced the incidence of calcification. It is considered likely that the calcified lesions may harbor living tubercle bacilli, because all 6 children whose disease relapsed had intracranial calcification.

Twelve roentgenograms with line drawings; 1 photograph; 6 tables.

JOHN H. JUHL, M.D.  
University of Wisconsin

**Massive Disseminated Intracranial Calcification Following "Serous Tuberculous Meningitis."** John Lorber. *Am. Rev. Tuberc.* 78: 101-105, July 1958.

This case report describes a two-year-old child in whom signs of intracranial involvement developed during the course of miliary tuberculosis. A pneumoencephalogram showed depression of the left lateral ventricle with a shift toward the right. There was some widening of the coronal suture indicating increased intracranial pressure. Fourteen months after the onset of meningitis, which was serous in type, faint calcific shadows became visible. Subsequent roentgenograms showed a large number of small irregular calcifications over the surface of the convexities of the brain bilaterally, as well as a number of individual calcifications within the brain substance. The greatest collection of calcium was in the left posterior parietal area at the site where the lateral ventricle had been depressed at the time of the pneumoencephalogram. No neurological symptoms or signs persisted and the calcification was more extensive than any previously reported in the literature.

Four roentgenograms. JOHN H. JUHL, M.D.  
University of Wisconsin

**Cerebral Vasospasm—Clinical and Experimental Evidence.** J. Lawrence Pool, Sherwood Jacobson, and Thomas A. Fletcher. *J.A.M.A.* 167: 1599-1601, July 26, 1958. (Neurological Institute, New York 32, N. Y.)

Large cerebral arteries, such as those of the circle of Willis, are capable of vasoconstriction, as demonstrated by angiography and direct visualization during intracranial surgery. Recognition of this vasospasm is often significant for diagnosis and prognosis after hemorrhage from an intracranial aneurysm. Localized spasm may be the only angiographic clue to the location of a recently ruptured aneurysm when multiple aneurysms are present.

The authors report studies in which vasospasm was induced by dissecting branches of the circle of Willis in cat, dog, monkey, and man. Vasodilatation could be induced in the constricted artery by local application of 2 per cent procaine or 3 per cent papaverine. Vasospasm already present as a result of hemorrhage from an aneurysm may not, however, always be relieved by topical application of these drugs at operation.

Two roentgenograms; 4 photographs.

J. S. ARAJ, M.D.  
Toledo, Ohio

**Encephalography with the Image Intensifier.** O. Wiedenmann and K. H. Leuchs. *Acta radiol.* 50: 39-47, July-August 1958. (In German) (Röntgenabteilung der Universitäts-Nervenklinik, Munich, Germany)

The authors describe the technique of encephalography done under fluoroscopic control with an image intensi-

fier fitted to a camera that allows cineradiography at will. Filling is under direct control of the eye, and the gas can be directed where needed. Individual pulsations of the brain and large arteries in the basal cisterns, as well as the corresponding movements of the fluid level, are visualized radiographically.

The fluoroscopic findings noted in certain abnormal states are described.

One photograph. CHRISTIAN V. CIMMINO, M.D.  
Fredericksburg, Va.

**Vertebral Angiography by Retrograde Femoral Catheterization.** G. Bonte, G. Riff, and E. Spy. *Acta radiol.* 50: 67-76, July-August 1958. (In French) (Cité Hospitalière de Lille, France)

Anatomically, it can be demonstrated that the thoracic aorta, the left subclavian artery, and the vertebral artery are often in direct continuity. Upon this fact rests vertebral angiography by catheterization of the femoral artery.

In a series of 75 patients, successful visualization of the vessels in the posterior fossa was possible by this means in 60 per cent. This is as good a percentage as with transcutaneous puncture, and the procedure is better tolerated by the patient, it is easier to perform, and the operator is exposed to much less radiation. Anesthesia is not required, even in the infant. Failures are attributable to abnormally tortuous iliac arteries and an unusual anatomic disposition of the vessels arising from the aortic arch. In case of failure, percutaneous injection is utilized.

Nine roentgenograms.

CHRISTIAN V. CIMMINO, M.D.  
Fredericksburg, Va.

**Carotid Angiography in Eight Cases of Unilateral Ophthalmoplegia.** Giovanni Di Chiro. *Acta radiol.* 50: 132-136, July-August 1958. (Neurologic Institute, University of Naples, Italy)

The author reports his experience with 8 cases of unilateral ophthalmoplegia investigated by means of arteriography. Conventional films of the skull, including special views of the optic canals and sphenosphenoidal fissures, were obtained in all cases, and carotid angiography was carried out on the side of involvement. In 4 cases angiography was also performed on the opposite side. In 2 cases in which these examinations failed to show any abnormality, they were supplemented by encephalography in order to rule out the presence of an intracranial space-occupying lesion.

In 2 cases the roentgenologic findings were all within normal limits. In 1 the presence of an intracranial tumor, partly extending through the sphenosphenoidal fissure into the anteromedial part of the middle cerebral fossa was eventually established, the final diagnosis being metastasis from a mammary carcinoma. In the other case, one of syphilis with complete ophthalmoplegia, a clinical diagnosis of a parasellar leptomeningeal inflammatory process was made.

Among the patients with positive roentgenologic findings was a twenty-year-old girl with moderate exophthalmos and impairment of the sixth cranial nerve. Roentgenograms of the skull revealed an area of bone destruction involving the superolateral part of the orbital cavity and extending to the external aspect of the sphenosphenoidal fissure. The posterior part of the affected orbital roof was elevated. A diagnosis of orbital cholesteatoma was made.

In 4 cases the presence of aneurysms of the intracranial portion of the internal carotid artery was demonstrated angiographically. Conventional roentgenograms in 1 instance showed a large erosion of the sella turcica. In another patient a huge cystic calcification partly corresponding to the walls of the aneurysm was seen.

The cause of the unilateral ophthalmoplegia in another case was found angiographically to be a berry aneurysm of the posterior communicating artery at the site of its origin in the internal carotid artery.

The importance of an accurate roentgenographic investigation, including carotid angiography, in every case of unilateral ophthalmoplegia is emphasized.

Nine roentgenograms.

THEODORE E. KEATS, M.D.  
University of Missouri

**Changes in Cerebral Circulation During Carotid Angiography with Sodium Acetizoate (Triuril) and Sodium Diatrizoate (Hypaque). An Experimental Study.** Erik Kågström, Percy Lindgren, and Gunnar Törnell. *Acta radiol.* 50: 151-159, July-August 1958. (Serafimerlasarettet, Stockholm, Sweden)

The authors investigated the systemic blood pressure and blood flow in the superior sagittal sinus following the injection of Triuril (sodium acetizoate) and Hypaque (sodium diatrizoate) into the common carotid artery in cats. The effect of Triuril varied, but in typical cases there was an increase in the blood flow frequently amounting to 100 to 300 per cent and lasting for several minutes. Corresponding amounts of Hypaque produced no change in blood flow.

The increased outflow from the superior sagittal sinus that follows injection of sodium acetizoate into the carotid artery is believed to be due to the direct effect of the contrast medium upon the intracranial vessels—a direct paralysis of the smooth muscle fibers in the walls of the small vessels.

It has been stated by others that sodium diatrizoate causes much less discomfort during carotid angiography than does sodium acetizoate. There may be some relationship between the incidence of unpleasant reactions and the vasodilator action of the medium.

The fact that a contrast medium has a considerable vasodilator effect does not necessarily mean that it is unsuitable for carotid angiography. In any case such a substance seems to be better than contrast media causing vasoconstriction and a decrease of flow, at least in patients with an impaired cerebral circulation. On the other hand, the vasodilator effect may conceivably have a bearing on the occurrence of cerebrovascular complications after carotid angiography.

One figure; 1 table. THEODORE E. KEATS, M.D.  
University of Missouri

**The Collateral Circulation in Thrombosis of the Internal Carotid Artery and Its Branches.** M. Rovira, R. Jacas, and A. Ley. *Acta radiol.* 50: 101-107, July-August 1958. (Department of Neurosurgery of the School of Medicine, Barcelona, Spain)

Among 10 cases of thrombosis of the internal carotid artery or its branches compensatory circulation was demonstrated angiographically in 7: in 2 cases through the external carotid arteries, in 2 through the circle of Willis, and in 3 cases through the connection of the terminal branches of the cerebral arteries. It is concluded that this compensatory circulation takes place in almost all cases of thrombosis and the degree of clinical

recovery bears no relation to the subsequent angiographic findings. Although the compensatory circulation was quite well established in most of the studied cases, only 1 patient recovered from hemiplegia.

Four roentgenograms.

THEODORE E. KEATS, M.D.  
University of Missouri

**Blood Pressure and Heart Rate Responses in Carotid Angiography with Sodium Acetrizoate (Triurol). An Experimental Study in Cats.** Percy Lindgren and Gunnar Törnell. *Acta radiol.* 50: 160-174, July-August 1958. (Serafimerlasarettet, Stockholm, Sweden)

The blood pressure and heart rate were recorded during angiography of the carotid artery in 41 cats. The injections (0.05 to 0.4 ml.) of the contrast medium sodium acetrizoate (3-acetylaminio 2,4,6-tri-iodobenzoate), or Triurol, were made into the common carotid artery or, in some cases, into the internal carotid artery.

A decrease in blood pressure of 10 to 50 mm. Hg occurred and the heart rate was reduced 20 to 40 per cent. In some cases there was a slight and transient initial rise in blood pressure. The latency of the responses was two to three seconds, and, as a rule, they lasted less than one minute.

The circulatory responses seem to be elicited *via* an effect of the contrast medium on vasomotor structures in the brain. It is evident that the bradycardia is due to vagal impulses, but only the initial phase of the decrease in blood pressure is caused by the reduced heart rate. The major cause seems to be a reduction of the sympathetic vasoconstrictor tone.

Seven figures.

THEODORE E. KEATS, M.D.  
University of Missouri

**Pneumographic Investigation of the Cervical Spine.** Jan Jirout. *Acta radiol.* 50: 221-225, July-August 1958. (Charles University, Prague, Czechoslovakia)

This author presents his technic for performing cervical spinal pneumography, and states the advantages of air studies over oil myelograms. Air is quickly resorbed, it causes no reaction in the leptomeninges, and it more clearly outlines the spinal canal and cord than the column of oil, which tends to break up into droplets. In addition, the air study is without damage to the patient and there is no danger of introducing oil into the cranium on cervical examinations.

The patient is seated with the head in anteflexion, held lower than the cervical spine. After lumbar puncture, 20 to 30 c.c. of air is injected through the spinal needle, and lateral films will then show the dorsal aspect of the spinal cord. To transfer the air to the anterior part of the subarachnoid space so that the ventral aspect of the cord may be seen, the patient is helped to a prone position on the table, keeping the head flexed and lower than the cervical spine. With head maintained in position, well over the table edge, he is rolled to the supine position. In this position the neck is hyperextended, and cross-table lateral views are made. The anterior wall of the spinal canal and the spinal cord are clearly outlined, so that disk protrusions may be diagnosed if present. Additional films made while varying the head position from extension to horizontal will help show the ventral aspect of the canal when filling has been insufficient.

Seven roentgenograms; 4 photographs.

DON E. MATTHIESEN, M.D.  
Phoenix, Ariz.

**Combination of Encephalography with Small Amounts of Air and Myelography of the Cervical Spinal Canal.** K. Lewit. *Acta radiol.* 50: 187-189, July-August 1958. (Neurologic Hospital, Charles University, Prague, Czechoslovakia)

The procedure of pneumoencephalography can successfully be expanded by maneuvers described in this paper, so as to allow upper cervical air studies at the same time. This combination examination has been found especially useful in the diagnosis of herniation of the cerebellar tonsils and for differentiating upper cervical disk lesions from arachnoiditis.

Pneumoencephalography is first performed, with about 20 c.c. of air. After the ventricles have been studied in the usual way, and while the patient is supine, the head is retroflexed, allowing air to escape into the spinal canal *via* the third and fourth ventricles. Following this, the patient is slowly raised to the sitting position, which transfers the air into the subarachnoid spaces. The order in which the ventricles and the subarachnoid spaces are filled may be varied as desired.

Because in the early part of the examination there is no superimposition of subarachnoid gas over the ventricular regions, film detail and definition of the ventricles are especially distinct.

DON E. MATTHIESEN, M.D.  
Phoenix, Ariz.

**Spasm of the Cricopharyngeal Muscle as Cause of Dysphagia After Total Laryngectomy.** Robert Schöbinger. *Arch. Otolaryng.* 67: 271-275, March 1958. (130 W. Kingsbridge Rd., Bronx 68, N. Y.)

Spasm of the cricopharyngeal muscle must be considered as a possible cause for dysphagia arising after either laryngectomy alone or combined with a radical neck resection. Its incidence is slightly higher in the latter surgical group.

The author has reviewed the records and roentgenograms of the 49 patients who in the period from Jan. 1, 1955, to Oct. 31, 1956, underwent surgery for malignant neoplasms of the intrinsic and extrinsic larynx at the Roswell Park Memorial Institute (Buffalo). Operations included 2 laryngofissures, 20 total laryngectomies, 22 combined total laryngectomy-radical neck dissections, and 5 combined total laryngectomy-partial pharyngectomy-radical neck resections. Only patients with a total laryngectomy or combined total laryngectomy-radical neck resection are included in the present analysis.

In the group of 20 patients who had undergone total laryngectomy, normal esophagograms were obtained in 8 instances. There were definite signs of spasm of the cricopharyngeal muscle in 4. In the remainder no barium swallow studies had been performed or this examination was carried out in the presence of a nasogastric feeding tube which was left in place because of clinical evidence or suspicion of a postoperative pharyngeal fistula.

Among the 22 patients who had been subjected to a combined total laryngectomy-radical neck resection, 8 had normal barium swallows. In 6 patients, however, there existed a definite spastic constriction of the cricopharyngeus. No postoperative esophagograms were available in 3 cases and in 5 a barium swallow examination was obtained in the presence of a nasogastric tube.

All 10 patients exhibiting roentgenographic dysfunction of the cricopharyngeal muscle complained, at the time of the x-ray examination, of variably severe dys-



phagia. In some this consisted merely in mild discomfort on swallowing solid food, while others were asymptomatic only on clear liquids. It is noteworthy that the roentgenographic intensity of the cricopharyngeal spasm paralleled the clinical severity of dysphagia in most instances.

Only 2 of the 10 patients with postoperative dysphagia and roentgen evidence of cricopharyngeal spasm had exhibited roentgenographic signs of esophageal dysfunction prior to surgery.

None of the esophagograms obtained in patients with an indwelling nasogastric feeding tube showed clear evidence of spasm of the cricopharynx.

It is difficult to name any single cause for the postoperative occurrence of spasm of the cricopharyngeal muscle. Worthy of consideration are several factors, such as a decrease in the local blood supply, interference with the esophageal innervation, local irritation, recurrent carcinoma, metabolic disturbances, or neuromuscular disorders. The last two conditions may be latent in certain individuals and become manifest in the form of cricopharyngeal dysfunction only after episodes of stress.

Five roentgenograms.

**External Ventricular Laryngocele.** Edward Newell Burke and J. Laurence Golden. *Am. J. Roentgenol.* 80: 49-53, July 1958. (233 Winthrop St., Medford, Mass.)

A laryngocele is an abnormal distention of the laryngeal ventricle, the small recess or slit which is located between the true vocal cords and the false cords, ending in a blind pouch or sacculus. If saccular dilatation of this pocket extends lateral to and above the false cords, it is referred to as an *internal laryngocele*. This differs in size and extent, at times reaching as high as the base of the tongue.

The *external laryngocele* is formed by perforation of the sacule through the thyrohyoid membrane into more superficial layers of the neck. These laryngoceles may be very small or so large as to extend from the mandible to the clavicle.

Congenital weakness of the thyrohyoid membrane or an abnormally long ventricle may predispose to external laryngocele formation. Increase of intralaryngeal pressure from coughing, blowing, shouting, etc., may be a disposing cause. External laryngoceles may contain fluid and may sometimes become infected.

The roentgen appearance is that of an air-filled cavity in the cervical soft tissues. On an anteroposterior view the shadow is seen just lateral to the thyroid cartilages. Upright films may show a fluid level. There is considerable variability in size. On barium swallow the laryngocele does not fill, which serves to differentiate it from a pharyngeal diverticulum. Laminagrams may help to demonstrate associated distortion of the laryngeal air passage.

One case is reported.

Three roentgenograms; 1 diagram.

DON E. MATTHIASEN, M.D.  
Phoenix, Ariz.

**A Simple Method for Taking Roentgenograms of an Infant's Ear.** Béla Rossmann. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 86: 741-748, June 1957. (In German.) (Besnyöi-u. 9.II.5, Budapest XIV, Hungary)

The roentgen examination of the infant's ear is of importance, since otitis and mastoiditis occur most fre-

quently in infancy. Present methods are in general inadequate, especially on account of the small size of the pneumatized parts. A simple method is described which requires no anesthesia and no special apparatus.

The infant is placed on the examination table in a prone position, with his head turned to one side. The head should not lie horizontally, but slightly obliquely, with the flat lateral part of the face downward. The central ray is directed craniocaudally by 15° to enter at the contralateral tuber parietale and pass to the pneumatized area of the ear to be examined. By turning the head, the other side is examined in the same way, while the body of the infant need not be displaced from the middle line. The angles of tilting obtained in this position suffice to project even the small antrums of the newborn so as to separate them from projections of the semicircular canals and other disturbing structures.

The good results of this technic are demonstrated by a number of examples.

Eight illustrations, including 5 roentgenograms.

AUTHOR'S ABSTRACT

**Roentgenograms of Normal Infant Ears.** Béla Rossmann. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 88: 162-167, February 1958. (In German.) (Besnyöi-u. 9.II.5, Budapest XIV, Hungary)

Owing to the technical difficulties of examining infants' ears, published data as to the time of development of the cell system are inconsistent. One writer, for instance, states, on the basis of histologic examinations, that cells appear by the end of the first or early in the second year, while another claimed to have demonstrated cells on intrauterine films.

By means of his simple roentgen method (see preceding abstract) the author studied the cell system in intact and diseased infantile ears as delineated on 1,000 roentgenograms. Individual variations were observed in the pneumatization of healthy ears. Well developed cell systems were found in the newborn, but usually at that age only an antrum is present. The antrum grows gradually in the first three months of life and in the third month cells appear, first above and then lateral to it. From this time on, gradual extension of the cell system takes place. Generally speaking, the presence of a cell system is to be taken into consideration after the third month.

Pneumatization exceeding the normal was repeatedly observed as an individual variant. Reduced pneumatization was due, in the vast majority of cases, to inflammatory processes. Latent mastoiditis revealed by x-ray examination and verified by operative autopsy was not infrequently observed.

Fourteen roentgenograms; 1 table.

AUTHOR'S ABSTRACT

**Roentgen Anatomy of the Infant Ear.** Béla Rossmann. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 89: 44-52, July 1958. (In German.) (Besnyöi-u. 9.II.5, Budapest XIV, Hungary)

The macerated temporal bone of the newborn falls into three parts: (1) the squamous portion, (2) the petromastoid part, (3) the annulus tympanicus. The antrum develops between the first and second parts, in the squamomastoid suture, while the recessus epitympanicus develops in the petrosquamous suture. The first appearing cells protrude above and laterally into the squamous portion; those developing later extend backward, into the mastoid part.



In order to clarify the relationships of the roentgen projections of anatomic structures, the author obtained films of macerated and formalin-fixed preparations of temporal bones, the individual parts being labeled with metal markers or radiopaque substances. A lateral film was made with the author's own technic (see abstract on p. 775), and an anteroposterior film in Gefferth-Towne's position projecting the petrous bone into the orbit. Finally an axial roentgenogram of the skull was obtained, representing a map of the structures accommodated by the temporal bone. The anatomic parts thus depicted present a conspicuous and distinctive picture. The small aerated area of the infant ear can be well delineated by this means.

To support the claim that the aerated area on the film corresponds to the area of pneumatization, the author filled the cell system of a formalin-fixed preparation with a radiopaque substance introduced through the eustachian tube. The opacity produced in this manner fully corresponded to the area assumed to be pneumatized.

For examination of the projection and the course of the external meatus, it was filled, prior to filming, with a sterile opaque substance in living persons. The meatus, resembling a split on account of its adjacent walls, displays in infancy an oblique course, wherefore its shadow is not disturbing. In infancy, there is no bony external meatus, the os tympani being present only as a thin bony ring termed the annulus tympanicus.

Finally, the form and situation of neighboring anatomic structures frequently represented on films of the ear are described.

Twelve illustrations.

AUTHOR'S ABSTRACT

### THE CHEST

**Bronchogenic Carcinoma Complicating Pulmonary Tuberculosis: A Report of Eight Cases and a Review of 140 Cases Since 1932.** John M. Carey and Allen E. Greer. *Ann. Int. Med.* 49: 161-180, July 1958. (J. M. C., 430 Northwest Twelfth St., Oklahoma City, Okla.)

The authors review 140 cases of bronchogenic carcinoma complicating pulmonary tuberculosis found in the English literature between 1932 and 1957, and present an additional 8 cases of their own. Over 95 per cent of the patients having the combined diseases were males, and the age distribution was the same as for bronchogenic carcinoma alone. The usual types of primary lung tumor were encountered in the same order of frequency as would be anticipated in a series which was 95 per cent male.

There were no unusual pathological features of the tuberculosis, which was most often bilateral. Twenty-eight per cent of the cases were moderately advanced, and 47 per cent far advanced. Seventy-five per cent showed acid-fast bacilli within one year of the diagnosis of the combined diseases.

In this study, derived largely from necropsy reports, cancer occurred in the opposite lung in 29, or in the same lung but well removed from the tuberculous process in another 46. The tuberculosis and cancer were closely associated in 56, and 17 cases were indeterminate. In some cases there was good reason to feel that the cancer, by physical extension or as a result of inanition, may have caused a breakdown of pre-existing quiescent tuberculosis or allowed its spread. No evidence was produced to show the development of cancer from the wall of a chronically diseased tuberculous cavity.

There were no specific clinical differences between the two conditions, and the only certain means of clinical distinction was by appearance of signs of inoperability of the cancer. Quantitative differences in symptoms and findings do occur which suggest the diagnosis of either disease alone, or of their combination. Failure to achieve or to maintain general improvement during present-day treatment of tuberculosis in a middle-aged man should suggest the possibility of complicating neoplasm.

Radiographic signs of help in the diagnosis of bronchogenic carcinoma complicating tuberculosis, as summarized by Hauser and Glazer (*Radiology* 65: 680, 1955), are briefly mentioned. They include: (1) unilateral prominence of the pulmonary hilus; (2) paratracheal lymph node enlargement; (3) atelectasis, particularly in the lower lung fields; (4) nodular densities greater than 3 cm. in diameter; (5) bony destruction.

The authors consider the relationship between pulmonary tuberculosis and bronchogenic carcinoma unsettled. It is currently believed that there is neither a negative nor a positive correlation, and it is apparent that the diseases are not mutually exclusive. It is felt that this association may be noted more frequently in the future with increased survival of patients afflicted with tuberculosis.

Of the 148 patients, only 21 received definitive treatment for bronchogenic carcinoma. Only by alert diagnosis and aggressive treatment can this unfavorable combination of diseases be improved.

Eleven roentgenograms; 1 table.

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**Circumscribed Intrapulmonary Hematoma Presenting as a "Coin Lesion."** Howard A. Buechner and Jordan Thompson. *Dis. of Chest* 34: 47-54, July 1958. (VA Hospital, New Orleans, La.)

A case of circumscribed intrapulmonary hematoma following a nonpenetrating injury of the chest is reported. This occurrence is apparently rare but should be considered in the differential diagnosis of "coin lesions." On the film a hematoma presenting as a "coin lesion" cannot be differentiated from other conditions such as bronchogenic neoplasm. Even when there are signs of previous trauma to the chest, exploratory thoracotomy will usually be necessary to establish the correct diagnosis.

Only 4 cases comparable to the authors' could be found in the literature. In their patient, a sixty-year-old male, a routine chest film during an admission for inguinal hernia repair showed a sharply defined circular density in the right lower lung field measuring 3.5 X 4.0 cm. Healing fractures of several ribs were also seen. A few months prior to admission the patient had fallen and struck the right side of his thorax. One month prior to that injury a chest film had been essentially negative.

A right thoracotomy was performed, and a "cystic lesion" in the right lower lobe was found containing 6 c.c. of dark red blood with small clots. The wall of the cyst was dense and fibrous. It was diagnosed as an organized pulmonary hematoma. It apparently is the cystic formation which accounts for the persistence of such lesions.

Since most of the sharply circumscribed intrapulmonary hematomas thus far reported have been surgically excised, little is known as to their natural course.

It seems likely that in most instances they would gradually resolve, while in others they would eventually undergo fibrosis or possibly calcification.

Three roentgenograms; 1 photomicrograph.

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**Pulmonary Manifestations of Choriocarcinoma.** S. F. Lemahieu, H. Lamiroy, and R. Pannier. *J. belge de radiol.* 41: 195-217, 1958. (In French) (Bruges, Belgium)

Some general considerations on choriocarcinoma are reviewed. Of particular interest to radiologists are three types of pulmonary roentgenographic findings. The first is the isolated pulmonary nodule. The second consists in multiple relatively large nodules, perhaps with some intervening change which may be suggestive of a bronchopneumonia. The third is the micronodular or miliary form, in which multiple tiny nodules, approximately 3 mm. in diameter, are observed. For some reason there is a tendency for these to predominate in the lower lung fields.

The third type is associated with endo-arterial lesions which slowly progress until there is occlusion of the pulmonary artery, with death after a relatively long interval. The authors insist that the histologic picture of malignancy or benignancy plays no practical role in the intravascular localization of tumor masses. They use the generic term trophoblastosis and speak of this condition as pulmonary endo-arterial trophoblastosis.

Eight roentgenograms; 1 table.

CHARLES M. NICE, JR., M.D., Ph.D.  
Tulane University

**On Certain Pulmonary Talcomas.** J. Roujeau and Y. Rose. *J. franç. de méd. et chir. thorac.* 12: 330-336, 1958. (In French) (Hôpital Laënnec, Paris, France)

Since 1953 the authors have performed more than 1,500 bronchographies with iodized oil containing talcum powder in suspension to prevent alveolar flooding. In 2 patients with carcinoma of the lung treated by irradiation there was retention of the opaque medium following bronchography. In one of these no appreciable reaction was present in the lung upon its removal. In the other there was a type of sclerotic granuloma with foreign-body reaction, as well as a diffuse thrombosing pulmonary arteritis. On this basis, the authors conclude that retention of the contrast agent and previous alteration of the pulmonary parenchyma are necessary factors in the production of talcoma following the use of their Lipiodol-talc mixture.

Two roentgenograms; 3 photomicrographs.

CHARLES M. NICE, JR., M.D., Ph.D.  
Tulane University

**Hydatid Cyst of the Lung with Bronchographic Evaluation of Treatment by Internal Suture of the Pericyst.** Maurice Srouji, Rahk Mulhim, and John L. Wilson. *J. Thoracic Surg.* 35: 779-794, June 1958. (M. S., Boston City Hospital, Boston, Mass.)

During the past ten years, 62 patients with primary hydatid cyst of the lung have been treated surgically at the American University Hospital in Beirut, Lebanon, without mortality. Marsupialization of the cyst to the chest wall followed by open drainage of the pericyst was employed in a few cases, but this procedure has been abandoned. One of the following three techniques is

now advised—pulmonary resection, dissection of the pericyst, or removal of the hydatid membrane and internal suture of the pericyst. The last has been found to be the easiest, safest, and most satisfactory method of treatment in most cases and was carried out in 42 of the patients in the authors' series, with low morbidity and minimal complications.

It has been possible to follow 26 of the 42 patients. No significant residual symptoms requiring treatment and no recurrences due to secondary cyst formation were found in this group. Anatomic results were checked in 20 patients by bronchography performed from a few months to several years postoperatively. In 12 patients the cysts were simple and in 8 complicated. In the bronchograms of 17 patients, no residual cavity or bronchiectasis was demonstrated; the remaining 3 showed either slight localized bronchiectasis or minimal residual cavitation.

While a long-term follow-up of a greater number of patients is necessary before a thoroughly objective study of this method of treatment can be completed, on the basis of present evidence it is justifiable to recommend internal suture as suitable for most hydatid cysts of the lung.

Eight figures, including 9 roentgenograms; 3 tables.

**Bronchopulmonary Aspergillosis with Alternating Bullae and Parenchymatous Consolidation.** J. Tapie, J. Monnier, Y. Le Tallec, and A. Delaude. *J. franç. de méd. et chir. thorac.* 12: 130-135, 1958. (In French) (Toulouse, France)

Pulmonary aspergillosis presents variable radiographic pictures. There is a parenchymal form, with multiple nodules in the lungs, while another type shows invasion of a bronchus with gradual enlargement and cavity formation, sometimes with a filling defect in the cavity.

The present report concerns a patient with parenchymatous consolidation of the left upper lobe. Though a tuberculin test was negative, there were clinical signs suggestive of tuberculosis, and treatment with streptomycin, isoniazid, and P.A.S. was given, resulting in considerable clinical improvement. After the parenchymal infiltration disappeared, large emphysematous blebs or bullae remained. The left upper lobe was removed and revealed evidence of aspergillosis in the wall of the apico-dorsal segment.

Seven roentgenograms.

CHARLES M. NICE, JR., M.D., Ph.D.  
Tulane University

**Bronchiectatic Aspergilloma and Bronchial Aspergillosis.** J. P. Lemerleier and Manouvrier. *J. franç. de méd. et chir. thorac.* 12: 154-163, 1958. (In French) (Rouen, France)

A 53-year-old woman was seen with symptoms of an acute pneumonia in 1942. There was a consolidation in the left upper lung field which did not disappear with ordinary therapeutic agents. Apparently at that time no evidence of tuberculosis was found and there was no definite sign of neoplasm.

Five years later the patient had hemoptysis. She was now considered tuberculous and was placed in a sanatorium, where she remained four years. This period was characterized by mucopurulent expectoration and rather frequent hemoptyses. No specific therapy was given.

In 1954 the patient was again hospitalized, in bad

condition. Roentgenograms now revealed a rather homogeneous opacity in the left upper lung field measuring 8 by 5 cm., quite well demarcated from the rest of the lung. Tomograms showed a characteristic image called by the French *image en gretot* and often spoken of as a fungus ball in English publications. This consists of a cavity containing a radiolucent air space within which is a certain amount of solid material. The patient was operated on approximately thirteen years after the onset of symptoms and died approximately thirty hours after the operation. Pathologic studies confirmed the diagnosis of aspergillosis.

Eight roentgenograms; 2 photomicrographs; 1 photograph.

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Tulane University

**Silicosis and a Few of the Other Pneumoconioses: Observations on Certain Aspects of the Problem, with Emphasis on the Role of the Radiologist.** Caldwell Lecture, 1957. Eugene P. Pendergrass. Am. J. Roentgenol. 80: 1-41, July 1958. (Hospital of the University of Pennsylvania, Philadelphia, Penna.)

**Simple Silicosis:** The characteristic lesion of simple silicosis is a circumscribed nodule of hyaline fibrosis. These nodules are usually located along and between the vessels and the bronchial branches of either lung. Not often are they demonstrable in the apical, peripheral, or lower lung fields. They may at times appear to be limited largely to one lobe.

The nodulation may or may not show progressive changes. It may disappear to be replaced by massive shadows. The hilar lymph nodes at times may enlarge. Coalescence of discrete nodules may take place to form conglomerates, and conglomerate lesions may also occur primarily. These are usually found in the upper lung fields. If they show no change on serial examinations over several years, they may properly fall within the simple silicosis class.

Emphysema may or may not develop in simple silicosis, with no definite relationship to the roentgenographic extent of the disease. It may be focal or generalized.

**Silicosis with Infection:** Presence or absence of infection is not always diagnosable on a single examination, although serial films may show slight change in the presence of active infection. Infection may modify the lesions or produce other lesions such as calcification, cavitation, pleural changes, tracheobronchial deformities, etc. The nature of the superimposed infection is usually not revealed by x-rays but in the majority of patients one may correctly suspect tuberculosis.

The trachea may be displaced; paratracheal node calcifications may be seen; x-ray evidence of cor pulmonale may be apparent; diaphragmatic flattening or irregular peaking from pleural adhesions may be encountered; hilar displacement, enlargement, or calcifications may be seen; and at times the shadows of massive lung lesions may be superimposed over intrathoracic structures to cause diagnostic confusion. Nodulation may be seen in the presence of infection, as it is in simple silicosis.

**S&T nodulation** is a descriptive term employed for lesions midway in size between nodulations and massive lesions.

Massive shadows measure from 5 to 20 cm.; are round, oval, or wedge-shaped; and may involve part or all of a lobe, or more than one lobe. These massive lesions may contain dilated bronchial radicals, produc-

ing air shadows resembling cavities. Normal anatomic positions of the lung vessels may be distorted by contraction of lung structures, and the fibrosing effect upon contained blood vessels may constrict or occlude them.

Serial chest films may show a migration of massive lesions hilarward in certain cases. This on later films may simulate great enlargement of hilar lymph nodes and mistaken diagnoses of lung carcinoma are not uncommon. It is to be emphasized that massive unilateral lung lesions may be found in silicosis without nodulation elsewhere. Anterior or posterior location of such lesions does not permit reliable differentiation between neoplasm and silicosis.

Other lung abnormalities which may be observed in association with silicosis are bleb and bulla formation, bronchiectasis, lung abscess, cavity formation, and pneumothorax.

**Tuberculosis and Silicosis with Tuberculosis:** Calcification observed in massive lesions is presumptive of tuberculosis or histoplasmosis. Also, tuberculo-silicosis may be presumed to be present upon demonstration of large bilateral areas of conglomerate or massive fibrosis. These areas commonly grow slowly over the years and may show associated emphysema, displacement by contracture of lung structures, calcification, and cavity formation.

In most cases a fresh tuberculous infection is superimposed on an active, progressive silicosis; and there is a progressive extension to death. In a second, smaller group of cases, the silicosis and tuberculosis seem to co-exist independently of each other, neither modifying nor accelerating the other.

The lesser incidence and severity of tuberculosis observed today in the general population carries over into the silicosis group as well.

Gross overexposure to silica and complicating infection, especially tuberculosis, occasionally produce an unusual, rapidly developing silicosis. This progresses from an early haze over the lower lobes to advanced lobular or lobar consolidation.

In simple silicosis with discrete nodulation, pulmonary physiology is normal. When conglomerates develop, the lung is not fully able to compensate, and pulmonary function studies show findings similar to those in diffuse emphysema. Roentgen findings and pulmonary function are only crudely comparable.

**Asbestosis:** In asbestosis pathological changes and symptoms may be present for some time, and usually fibrosis has extended to involve the visceral pleura before radiographic changes become apparent. These findings first appear in the lower half of the thorax and are often best seen in the left lower lobe.

Initially, there may be limitation of diaphragmatic motion, blunting of the costophrenic sulci, and loss of sharp definition of the cardiac outline. Later the pleural thickening becomes much more pronounced, and the lower lung fields appear underventilated, with a ground-glass-like density. Nodular or irregular stringy shadows may develop.

Patients with asbestosis usually retain their average capacity to work, although there is a slight to moderate reduction of total lung volume. There is ordinarily no severe impairment of ability to ventilate the lung.

The disease evidently does not increase susceptibility to tuberculosis.

**Coal Workers Pneumoconiosis:** Contrary to previous wide belief, coal dust evidently can produce pneumoconiosis, but this is pathologically distinct from silicosis.

There may be a simple pneumoconiosis with foci scattered throughout the lungs, each surrounded by a small area of emphysema; or there may be a fibrosis which starts with a few foci, and progresses to form a dense mass occupying a lobe or a lung.

The simple form radiographically shows scattered minute pulmonary shadows. The designation complicated pneumoconiosis refers to cases showing larger shadows. When tuberculosis becomes superimposed, its shadows can usually be distinguished roentgenographically from those of the pneumoconiosis.

It is difficult to correlate the x-ray appearance and the pulmonary disability in any given case. Measurements of the level of the diaphragm and its movements seem at present the best objective index of disability due to pneumoconiosis.

Unusual massive lesions have been reported in the lungs of coal miners with rheumatoid arthritis (Caplan's syndrome), but the relationship is not yet clear.

**Silicosis and Pulmonary Carcinoma:** The lesions of silicosis may produce radiographic shadows and clinical symptoms which resemble those of carcinoma. A high index of suspicion for carcinoma is indicated, and body-section radiographs are often helpful in such cases. The need for biopsy to confirm diagnosis before irradiation or chemotherapy in the presence of a pneumoconiosis is emphasized.

In closing this lecture, the author makes a firm plea for establishment, in the United States, of guides and criteria for diagnosis and evaluation of extent of disability in pneumoconiosis. The organization of a National Committee on Pneumoconiosis Protection and/or Control is suggested.

Forty-eight roentgenograms; 7 photomicrographs.

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**Postoperative Aspiration Pneumonitis.** Gerald L. Baker and Gilbert W. Heublein. *Am. J. Roentgenol.* 80: 42-48, July 1958. (G. W. H., 85 Jefferson St., Hartford 6, Conn.)

During anesthesia, especially the induction phase, regurgitation and aspiration of gastric contents is not an uncommon occurrence. In some instances the anesthetist may not be aware that it has taken place. In any patient who regurgitates postoperatively, aspiration pneumonitis must be watched for, particularly after emergency surgery or obstetric delivery.

Pathologic changes which ensue in the lung are mainly due to the acid pH of the aspirated material. They consist of a granulomatous type of cellular response or of congestion, hemorrhage, mucosal de-epithelization, and polymorphonucleosis. Bacteria may cause secondary infection, but bacteria and enzymes apparently do not play a significant part in the primary pathology.

The roentgenographic findings are nonspecific, but resemble those of interstitial pneumonitis. Scattered areas of increased density, exaggerated bronchovascular markings, patchy emphysema, and atelectasis may be seen. The upper lung lobes are more often involved than the lower, and the right lung more often than the left.

Six cases illustrating the importance of acid aspiration pneumonitis are reported. Five of the patients were critically ill, and 3 died.

Seven roentgenograms; 2 colored photomicrographs.

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**Roentgenologic Studies Following Aspiration of Metallic Mercury.** W. Schulze. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 89: 24-30, July 1958. (In German) (Medizinische Universitätsklinik, Leipzig, Germany)

Ingestion of metallic mercury is generally believed to be tolerated without causing harm. Nevertheless, it occasionally has proved to be toxic and even fatal.

A case is reported in a female, aged 34, who for suicidal purposes had ingested large quantities of metallic mercury. This resulted in vomiting, with aspiration of some of the metal. The immediate reaction was chest pain, especially on deep inspiration. The temperature was moderately elevated, and there were pressure pain over both kidneys, diarrhea, and sinus tachycardia. Two weeks later marked stomatitis developed, with swelling of regional nodes. At this time constipation and an elevated sedimentation rate were noted. Improvement followed, but after an additional three months there was recurrent necrotizing gingivitis with alveolar pyorrhea and limited motion of the mandible. After seven months the patient could be discharged from the hospital.

Roentgen study of the chest at the beginning revealed minute metallic densities scattered throughout both lungs but predominating in the lower lung fields on the right side, with cluster formations at the bases. After three months the initial stellate appearance of minute metallic particles had changed into a more globular pattern. Three years later there was distinct clearing of the upper lung fields, but more accumulation of the mercury at the bases. Comparative tomographic studies suggested a decrease of metallic densities also in the lower lung fields.

Urinary findings indicated renal excretion of more than 3 gm. of mercury, calculated for a period of five years. There was no evidence of chronic intoxication, of damage to kidneys or to other organs, or of superimposed tuberculous infection.

Eleven roentgenograms. ERNEST KRAFT, M.D.  
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**Pleuritis in Systemic Lupus Erythematosus: Its Importance as an Early Manifestation in Diagnosis.** William A. Winslow, Lester N. Ploss, and Bernard Loitman. *Ann. Int. Med.* 49: 70-88, July 1958. (L. N. P., 241 Pennsylvania Ave., Freeport, L. I., N. Y.)

Pleuritis and pleural effusion, although long considered as cardinal signs in the clinical picture of systemic lupus erythematosus, have usually been regarded as late manifestations. Now that the early diagnosis of the disease has been facilitated by the "L.E. cell preparation," the authors felt that pleuritis as an early sign of this disease should be re-evaluated. Moreover, the striking improvement in prognosis with steroid treatment makes prompt diagnosis much more significant.

A total of 77 cases were studied, all proved, 23 by autopsy, and 54 by a specific set of criteria which are given in detail. Of the 77 patients, only 3 were males; 10 were less than twenty years old and 8 over fifty at the time of diagnosis. Pleuritis with or without effusion was found to be of common occurrence, being seen in 41 of 57 cases where roentgenograms were available. It was recorded in 10 of the 20 additional cases for which films were unobtainable.

The authors note that little has been written on the pathogenesis of pleuritis in lupus. This may be attributed to the fact that at autopsy one sees the end result of many successive episodes: usually there is terminal



effusion, and often fibrosis obliterates any other detail originally present. There seems to be general agreement that pleuritis in lupus tends to be bilateral, often occurring alternately on the two sides, and that the fluid, if any, is an exudate with a relatively low polymorphonuclear count and may demonstrate the "L.E. cell phenomenon."

Pleuritis is often an early sign of systemic lupus erythematosus. In 3 of the 57 cases it appeared as an isolated first sign. In 16 more it appeared with a few antecedent symptoms of the disease, notably arthritis or arthralgia. Despite this frequent association, sufficient weight is rarely given to systemic lupus erythematosus in the differential diagnosis of unexplained pleuritis, which most observers still regard as tuberculous or neoplastic until proved otherwise. Review of recent literature, however, indicates that the possibility of collagen disease is receiving a somewhat tardy recognition.

Pleuritis in this series often went on to complete clearance. In 14 of the 39 uncomplicated cases followed radiologically there was total clearance of one or more episodes and in 8 there was only a minimal residue. Survival following the first pleuritic episode averaged forty months. Bilateral pleuritis, either simultaneous or alternating, was seen in 23 uncomplicated cases; the process was limited to the left side in 13 cases, and to the right in 6.

In view of the increasingly favorable results of therapy in systemic lupus erythematosus, not only symptomatically but also in objective life prolongation, the prompt study of cases with unexplained pleuritis is urged for that disease as well as for tuberculosis and neoplasia.

Five roentgenograms; 7 tables.

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Iowa City, Iowa

**Tumors and Cysts of the Mediastinum. Survey of One Hundred Seventy-Four Mediastinal Tumors Treated Surgically During the Past Eighteen Years at the University of Wisconsin Hospitals.** Alfred J. Herlitzka and Joseph W. Gale. *Arch. Surg.* 76: 697-706, May 1958. (1300 University Ave., Madison, Wisc.)

The authors' group of 174 mediastinal tumors includes the following types: neurogenic, 35 (20 per cent); teratodermoid, 26 (15 per cent); bronchogenic cysts, 24 (14 per cent); pericardial cysts, 17 (10 per cent); thymoma plus cyst, 14 (8 per cent); lymphatic, 12 (7 per cent); goiter, 10 (6 per cent); miscellaneous, 36 (21 per cent).

Of the neurogenic type, 77 per cent were benign and 23 per cent malignant. Nineteen of the tumors in this group were neurofibromas. As in other series, most of the neurogenic tumors were located in the posterior mediastinum (83 per cent). The tumors varied from 2 cm. in diameter to massive lesions that almost completely filled the hemithorax. Radiographically these tumors appeared rounded although some were elongated or lobulated. Rib and vertebral erosion was seen in several cases. At times calcium was visualized.

The pathological diagnosis in the teratodermoid group was benign dermoid cyst in 17, benign teratoma in 7, and malignant teratoma in 2. One-third of these patients were asymptomatic. All 26 of these lesions were located in the anterior inferior mediastinum. They were usually circular or globular in type. Both of the malignant tumors were nonresectable. One was de-

tectable on a chest roentgenogram twelve years before surgery.

The bronchogenic cysts were usually located in the hilar or posterior mediastinal area. They were spherical, unilocular, fairly thin-walled cysts containing mucilaginous material. Only one of the cysts communicated with the tracheobronchial tree, producing an air-fluid level on the roentgenogram.

The pericardial cysts were typically located in the anterior inferior mediastinum. The appearance was that of a smoothly rounded, sharply demarcated lesion of uniform density, lying against the pericardium, diaphragm, and chest wall. Of the fourteen tumors in the thymoma or thymic cyst group, 10 were benign and 4 malignant.

The lymphoma group of 12 cases included lymphosarcoma, lymphoblastoma, Hodgkin's disease, and simple lymphoma. The relatively small number of lymphomas in the series results from the fact that in most instances this diagnosis is made without thoracotomy.

Seventy-five per cent of the mediastinal tumors were benign. Out of the 45 (25 per cent) malignant tumors, 20 were resectable. Several of the malignant tumors had been detected years before.

Fourteen roentgenograms; 2 diagrams; 2 tables.

DEAN W. GEHEBER, M.D.  
Baton Rouge, La.

**Lipothymoma Simulating Cardiomegaly. Case Report.** Irwin Roseff, Burton Levine, and Lawrence Gilbert. *Am. Heart J.* 56: 119-125, July 1958. (Newark Beth Israel Hospital, Newark, N. J.)

A case of lipothymoma, presenting as cardiomegaly, in a 28-year-old white man is reported. The patient had been discharged from military service because of "cardiac enlargement" ten years before entering the hospital. He had been asymptomatic until two years prior to admission, when he first became aware of exertional dyspnea, described as deep sighing, and infrequent episodes of chest pain. Yearly roentgenograms showed little change in the cardiac enlargement first noted in 1947, until six months before admission to the hospital. At that time further enlargement of the heart to the right was noted.

An electrocardiogram was normal. The chest roentgenogram showed an enlarged triangular cardiac silhouette with the right border extending well into the right hemithorax. This was interpreted as indicating pericardial effusion or pericardial cyst. Angiocardiography suggested a space-occupying mass to the right of the heart. A pericardial cyst was considered the most likely diagnosis.

The mediastinum was explored, and a large, smooth mass was found overlying the right lateral border of the pericardium, covered by mediastinal pleura. The tumor was "tear drop" in shape, pedunculated, with the apex extending into the superior mediastinum and the convex base just touching the diaphragm. Mobilization of the mass was simple, and the pedicle was dissected free. The patient made an uneventful recovery.

Grossly the tumor was encapsulated and appeared to be lipomatous in nature, measuring 13 × 12 × 5 cm. and being somewhat flabby. Histologically, it was found to consist of extensive areas of ordinary adipose tissue within which were strands of completely mature hyperplastic thymic tissue.

Only 11 cases of lipothymoma have been reported in the English literature. This tumor must be included



in the differential diagnosis of pericardial effusion, anterior mediastinal tumors, and cardiomegaly of undetermined origin.

Five roentgenograms; 3 photomicrographs; 1 photograph.

THEODORE E. KEATS, M.D.  
University of Missouri

## THE HEART AND BLOOD VESSELS

**Myxoma of the Right Atrium, with Variable Right-to-Left Shunt: Clinical and Physiologic Observations and Report of a Case with Successful Operative Removal.** E. Osborne Coates, Jr., and Ellet H. Drake. *New England J. Med.* 259: 165-169, July 24, 1958. (Henry Ford Hospital, Detroit, Mich.)

Myxoma appears to be the most common primary tumor of the heart, comprising about 50 per cent of reported cases. Since this lesion is now amenable to direct operation a correct diagnosis becomes important.

A 50-year-old white woman was seen with a history of dry cough, easy fatigability, and shortness of breath on slight exertion, for several months, with gradual progression of all symptoms. Abnormal physical findings were confined to the heart, where moderately prominent murmurs were heard over most of the precordium. Chest films showed clear lung fields and mild cardiac enlargement, primarily of the right heart. Cardiac catheterization proved the presence of an interatrial septal defect and showed arterial blood oxygen unsaturation. Presence of a right-to-left shunt was indicated. Arterial blood specimens obtained from the right atrium with the patient in varying positions showed a striking change in the degree of oxygen unsaturation. The final step in diagnosis was angiocardiology, which revealed a large, lobulated, filling defect in the right atrium with apparent protrusion through the tricuspid valve into the right ventricle. At open-heart operation a large, fungating tumor was found filling the right atrium, extending through the tricuspid valve, and prolapsing through the interatrial septal defect. The tumor arose from a small stalk and was completely removed with some difficulty. The patient went through a relatively uneventful postoperative course and appeared almost completely well six months after operation.

The authors note in retrospect that the most significant clue to the presence of intra-atrial tumor is a change in signs or symptoms associated with change in the patient's position, which produces varying degrees of valve interference and obstruction.

The extensive laboratory and cardiologic data are presented in three tables and a series of electrocardiograms. One photograph of the operative specimen and a selected film from the angiocardiac series are presented.

JAMES W. BARBER, M.D.  
Cheyenne, Wyo.

**Double Mitral Valve.** Louis A. Soloff, Jacob Zatu-chni, and Richard Licata. *Arch. Int. Med.* 101: 103-107, January 1958. (Temple University School of Medicine, Philadelphia 40, Penna.)

A double mitral valve is one of the rarest of congenital anomalies of the heart, only 17 cases having been recorded. The authors report the eighteenth case and, so far as they could determine, the only one in which cardiac catheterization and angiocardiology were performed.

The patient was first seen, in June 1954, at the age of

fifty-five, with a fracture of the mandible. The blood pressure in the right arm was 204/110 mm. Hg, in the left arm 170/110; in the lower extremities it was frequently unobtainable but when found (rarely) was 160/130. On the basis of the physical, roentgen, and angiocardiac findings, the patient was discharged from the hospital with a diagnosis of coarctation of the aorta, calcific aortic stenosis, presumably a bicuspid aortic valve, and left ventricular hypertrophy and enlargement. He was seen again in November 1956. About four months previously he had had a bout of dyspnea while in bed. Five subsequent attacks of nocturnal orthopnea occurred, with intervening continuous and progressive shortness of breath. Physical examination revealed tachypnea, cyanosis, and pulmonary edema. After recovery from dyspnea the blood pressure was 129/80 in the right arm and 116/78 in the left; it was not obtainable in the lower extremities. Compared with the previous studies, the chest roentgenogram revealed a slight increase in heart size but the electrocardiogram showed no significant change. On cardiac catheterization, the pressure in the right ventricle was 40-50/0 mm. of Hg and in the pulmonary artery 35/10. The pulmonary artery wedge pressure was 40/10.

In spite of the risk, the patient desired operative relief, and an aortic valvotomy was performed. Shortly thereafter, cardiac arrest occurred. Sinus rhythm was restored following cardiac massage and intracardiac epinephrine. The blood pressure was stabilized at 140/100 mm. of Hg with arterenol intravenously. The patient remained unconscious, however, and died two hours after surgery.

Necropsy disclosed a double mitral valve, coarctation of the aorta, calcific stenosis of a bicuspid aortic valve, and a horseshoe-shaped kidney. It is believed that the double mitral valve produced no recognizable signs or symptoms. All persons who have had this anomaly have died of causes unrelated to it and frequently in the sixth, seventh, and eighth decades of life.

The authors suggest that by high-speed or selective angiocardiology it might be possible to demonstrate a double left atrioventricular stream of contrast substance.

Two roentgenograms; 4 photographs.

**Clinical and Radiological Aspects of Calcification of the Mitral Region.** Eino Linko and Erkki Sysimetsä. *Brit. Heart J.* 20: 329-334, July 1958. (University of Turku, Finland)

In the detection of intracardiac calcifications fluoroscopy has long been considered superior to radiographic methods. The subjectivity of this technic, however, has limited its utility. Tomography, on the other hand, has developed to the point where it now provides a more reliable index of the extent of calcification. The constant evolution of corrective surgical procedures demands reliable preoperative evaluations which are afforded by complete tomographic examination of the heart.

In the study of 68 consecutive unselected patients with rheumatic mitral and/or aortic valvular disease tomography revealed calcification in 24. This was slight in 6, moderate in 10, and severe in 8 cases. It was not observed in patients under thirty years of age, nor was it seen in cases in which the onset of the disease dated back less than ten years. Otherwise age and the time interval following onset appeared to be without significance in this respect. Calcification was seen more

frequently where mitral stenosis rather than regurgitation was foremost.

Whether mitral valve calcifications are a contraindication to surgical intervention in the treatment of mitral stenosis has been debated. It has been shown, however, that in patients with calcification the operative mortality is much higher and the rate of successful valvulotomy is lowered. In the present series, where there were absolute contraindications to surgery, calcifications were severe involving not only the valves but the annulus fibrosus.

Tomograms were obtained in a slight oblique projection, about 20° rather than the usual 40–45° degrees, to avoid superimposition of various cardiac valves and object magnification, which is greater with the usual obliquity.

Two tomograms; 3 tables.

JOHN F. RIESSER, M.D.  
Springfield, Ohio

**Tricuspid Stenosis. Clinical Features in 12 Cases.** Thomas Killip, III, and Daniel S. Lukas. *Am. J. Med.* 24: 836–852, June 1958. (New York Hospital-Cornell Medical Center, New York, N. Y.)

Tricuspid stenosis has been identified clinically and confirmed by cardiac catheterization by the authors in 12 patients. It was associated with mitral disease in 4 cases, and with both aortic and mitral lesions in 7. In 1 the lesion was solitary. Two patients came to autopsy and 2 underwent tricuspid valvuloplasty.

The most striking clinical feature was a characteristic diastolic murmur with a thrill in the third, fourth, and fifth intercostal spaces to the left of the sternum. The increase in intensity during inspiration and the decrease during expiration aided greatly in identifying the murmur and differentiating it from that of mitral stenosis. The intensity of the murmur varied with respiration in the same manner as the transvalvular diastolic pressure gradient. An opening snap of the tricuspid valve was heard in only 3 cases. Dyspnea, fatigue, and edema were the most common symptoms, but the resulting disability was quite variable. Recurrent ascites was present in 3 patients.

Enlargement of the right atrium was observed roentgenologically in every patient, being best visualized in frontal and right oblique views. In 3 patients, the atria were gigantic and displaced the right border far into the lung. In another 3 patients the atria were only mildly to moderately enlarged. The largest right atria were encountered in the patients who had both tricuspid stenosis and insufficiency, atrial fibrillation, and right atrial pressures of 12 mm. Hg or greater at rest. When a giant left atrium was combined with a giant right atrium the cardiac silhouette was massive.

The angiocardigram was characteristic. The right atrium was enlarged and its opacification was prolonged. In the frontal films the tricuspid valve could be localized precisely as a thin line separating the well opacified right atrium from the less dense right ventricle. Abnormalities of the right ventricle, pulmonary artery and left heart reflected the associated valvular lesions.

Tall P waves, often taller than QRS in  $V_1$ , and low QRS complexes with an  $rsr'$  pattern in lead  $V_1$  were common features of the electrocardiogram.

The pulmonary vascular pressures and resistance in patients with mitral and tricuspid stenosis were lower than in patients with a similar degree of mitral stenosis alone. Pulmonary venous hypertension, however, was

not entirely prevented and most of the patients had pulmonary congestive symptoms of mitral stenosis, including orthopnea. The failure of 1 patient to improve following mitral valvuloplasty was attributed to the tricuspid stenosis.

Five cases are reported in detail.

Eight illustrations, including 4 roentgenograms; 2 tables.

**A Preliminary Report on a Study of Experimentally Produced Tricuspid and Mitral Valve Regurgitation.** Ian Monk, Thomas S. Reeve, James Kalokerinos, and John Wingfield. *Brit. J. Surg.* 46: 75–82, July 1958. (Royal North Shore Hospital, Sydney, Australia)

A brief discussion of intracardiac hemodynamics is given. Blood flow into the atrium from the major afferent veins and into the ventricle is relatively slow and under low pressure. By contrast, the backward flow of blood from the ventricle at systole, through an incompetent valve, is under high pressure and of jet-stream nature. Consequently, a large proportion of the propulsive force gained from ventricular systole is lost. Theoretically, if the atrium could be reduced in size and made less expansible, while at the same time backflow into the afferent veins could be reduced, kinetic energy would be conserved and forward cardiac output promoted. Several operations have been tried to produce these conditions.

The most promising procedure consists in creation of a baffle, a semi-rigid partly fixed structure, placed in the atrium near the face of the incompetent valve. The jet stream of backwardly propelled blood on striking the baffle will meet with resistance and a gain in forward propulsion will be effected. The baffle may be produced by appropriate invagination of the atrial wall through properly placed purse string sutures.

Reduced backflow in the afferent veins emptying into the atrium may be accomplished by changing the angle of entry of these veins and/or by constructing a type of flap-valve mechanism through wall plication or invagination. Backflow through large caliber veins may also be decreased by alteration of the lumen of the vein through placement of mattress sutures at varying axes so that the lumen is converted from a single large channel into two smaller tortuous channels. Such a situation does not greatly impair the low speed, low pressure, forward flow of the blood stream but will tend to block the high pressure back flow resulting from an incompetent valve at the moment of systole.

After these operations had been designed, tests were performed in numerous sheep on which artificial tricuspid or mitral incompetency had been produced by suitable procedures. Demonstration of the status of valve competency and degree of backflow is accomplished through angiocardigraphic procedures. Several of the animals showed favorable pressure relationships in the critical areas after reconstructive operations. Angiocardigraphic studies were confirmatory in showing much decrease in the amount of backflow.

The authors admit that hemodynamics of sheep hearts may be different from those of man but believe that the similarities are probably great. They also note that the small structures available for surgical manipulation in sheep make an exact technic more difficult than would probably obtain in man.

Twenty-three figures, including eight roentgenograms.

JAMES W. BARBER, M.D.  
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**The Dynamics of the Left Ventricular Border in Chronic Constrictive Pericarditis: An Analytic Roentgenkymographic Study with Remarks on the "Flat Top and V" Electrocardiographic Pattern.** Antonello Laconi. *Am. Heart J.* 56: 73-78, July 1958. (Istituto di Radiologia Medica e Terapia Fisica, Università di Palermo, Italy)

The author studied the dynamics of the left ventricular border in chronic constrictive pericarditis by means of analytic roentgenkymography and compared the results with the electrokymographic findings.

The electrokymographic findings in constrictive pericarditis have not been uniform. It is likely that this lack of agreement is due to the characteristics of the electrokymographic technic. Less variable results are obtained by analytic roentgenkymography because of the greater fidelity of registration of the morphologic, chronologic, and quantitative factors which this procedure permits.

The author's results, obtained by analytic roentgenkymography in 16 cases of chronic constrictive pericarditis, are reported. Such findings are of two main types: a first type, which consists of a straight line due to standstill of the ventricular border, observed in 9 patients, and a second type, trapezoid in form, corresponding to the "flat top and V" electrokymographic pattern, due to partial rigidity of the walls. It is suggested that the discrepancies in the electrokymographic findings may be explained by the kymanalytic results as follows: (1) The trapezoid pattern is not constant but only statistically prevalent. (2) Even in cases having a trapezoid type of movement, the electrokymogram may be deformed by variations in density of the paracardiac shadows.

Nine roentgenograms.

THEODORE E. KEATS, M.D.  
University of Missouri

**Occlusion of the Main Branches of the Pulmonary Artery without Formation of an Infarct, with Development of a Subacute Cor Pulmonale.** E. Sövényi, V. Balázs, and M. Dávid. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 89: 30-33, July 1958. (In German) (Medizinische Universität, Szeged, Hungary)

Occlusion of the main pulmonary artery by a thrombus or embolus is relatively rare as compared to embolism of the small peripheral branches. Pulmonary infarction secondary to occlusion of the main branch is seen in only 50 per cent of the cases. Cor pulmonale tends to develop in the acute and subacute as well as in the chronic stage of the occlusion.

A case is reported in which the main pulmonary artery became the site of an embolic occlusion. There was no associated pulmonary infarct but an acute cor pulmonale occurred.

The patient was a male, aged 28, with a history of sudden swelling of the left leg followed, a week later, by palpitation and dyspnea on exertion. There were cyanosis of the lips and a systolic murmur over the pulmonary artery, but the blood pressure was normal. The electrocardiogram showed right axis deviation. Roentgenologic study revealed enlarged hilar shadows and a bulge of the right portion of the heart, including the pulmonary trunk. A few days later the right hilus was still larger and showed an unsharp border. Pulmonary markings were decreased in both lower lung fields, and there were increased radiolucency of the right lower lung field, marked dilatation of the right ventricle,

and an increased bulge of the pulmonary artery. On the basis of the roentgen findings, a diagnosis of pulmonary artery occlusion without infarct was immediately established, but the patient died less than fifteen minutes later, following sudden collapse with cyanosis and dyspnea. Autopsy confirmed the impression of massive embolism of the pulmonary trunk and of the right main pulmonary artery and failed to disclose a pulmonary infarct.

One roentgenogram; 1 drawing.

ERNEST KRAFT, M.D.  
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**Transposition of the Pulmonary Veins.** Warren G. Guntheroth, Alexander S. Nadas, and Robert E. Gross. *Circulation* 18: 117-137, July 1958. (A. S. N., Children's Medical Center, Boston, Mass.)

Complete transposition of the pulmonary veins, or total anomalous pulmonary drainage, usually results in death in infancy, although a few patients live a number of years and an occasional one to adulthood. The authors review 20 cases. In 9 of these the pulmonary veins drained into the ascending left superior vena cava, in 4 into the coronary sinus, in 3 into the right atrium, and in 4 below the diaphragm.

The radiographic findings can usually be correlated with the level at which the pulmonary veins empty. If they drain into the left superior vena cava, the typical figure-of-eight silhouette is found. In the group in which the connection with the systemic circulation is below the diaphragm, the heart is of normal size and there is moderate to marked pulmonary vascular engorgement and congestion. Drainage directly into the right atrium may produce a "box-like" pattern, not specific, however, for this condition. When the veins empty through the left vena cava into the coronary sinus, there is some widening of the mediastinum but not a true figure-of-eight configuration.

Cardiomegaly was observed in all the authors' cases except those with drainage below the diaphragm. The pulmonary artery was abnormally prominent in over half the patients and pulmonary vascular engorgement was marked in all.

Catheterization revealed an interesting inverse relationship between right atrial pressures and systemic index.

Angiocardiography was performed in only a few of the 20 cases, and the authors do not consider it indicated except in cases in which surgery is under consideration and anatomic details not otherwise apparent are required.

In incomplete transposition of the pulmonary veins, the major abnormality is the anomalous drainage of part of the pulmonary return into the right atrium or its tributaries. Eleven cases of this type were studied.

The radiographic profile in this group was completely nonspecific, although quite similar to that in patients with atrial septal defects. Cardiomegaly was invariably present, with a characteristically right-sided ventricular configuration. The main pulmonary artery was abnormally prominent. Angiocardiography was done in none of these patients.

The authors include the clinical, physical, and electrocardiographic findings in each group of cases, as well as the surgical aspects.

Seventeen roentgenograms; graphs, electrocardiograms, and tables.  
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Pontiac, Mich.

**The Relation of the Aortic Root to the Ventricular Septum in Tetralogy of Fallot.** Leonard Leight and Lawrence A. Davis. *Am. Heart J.* 56: 129-135, July 1958. (University of Louisville School of Medicine, Louisville, Ky.)

The authors discuss the relation of the aortic root to the ventricular septum in tetralogy of Fallot. Their work, as well as that of others, has cast doubt upon the concept of overriding of the aorta in cases which clinically appear to be tetralogy of Fallot. Overriding of the aorta is probably not an important feature of this anomaly.

During angiocardigraphic study of patients with tetralogy of Fallot, it has become obvious that there is not simultaneous filling of the aorta and pulmonary artery from the right ventricle, but rather that there is initial filling of the pulmonary artery from the right ventricle, flow of the opaque material across the interventricular septal defect to the left ventricle, and, only after the latter event occurs, filling of the aorta.

Three cases of clinically classic tetralogy of Fallot are presented, in which angiographic studies demonstrate no overriding of the aorta. It is the authors' belief that the fact that the catheter enters the aorta cannot be taken as proof of overriding, since the aorta may be entered by an interventricular septal defect. Since the relationship of the aorta to the ventricular septum is a dynamic one, the determination as to whether or not overriding of the aorta is present is difficult even at autopsy.

There undoubtedly is an anatomic spectrum ranging from slight overriding of the aorta, which is physiologically insignificant, to cases with marked overriding, which is of physiologic significance. Even in the presence of considerable anatomic overriding of the aorta, the relationship of the pressures in the two ventricles and in the aorta will determine whether or not the aorta fills from the right ventricle.

These studies indicate that many cases of tetralogy of Fallot should be considered as a type of ventricular septal defect with pulmonic stenosis, in which overriding of the aorta is of no functional or surgical importance.

Twelve roentgenograms.

THEODORE E. KEATS, M.D.  
University of Missouri

**Coronary Artery Catheterization During Thoracic Aortography.** A. M. Johnson and William D. Logan. *Brit. Heart J.* 20: 411-415, July 1958. (Guy's Hospital, London, England)

Ever since the introduction of retrograde aortic catheterization for the purpose of radiological demonstration of the thoracic aorta and its branches, the importance of correct positioning of the catheter before injection of the opaque material has been emphasized. Fluoroscopic observations have proved useful in determining that the tip of the catheter lies free in the main aortic stream. The inadvertent entrance or occlusion of a coronary artery may result in myocardial infarction and/or death. [For a recent discussion of the visualization of the coronary circulation by occlusion aortography, see Deater and Frische: *Radiology* 71: 502, 1958.]

In the case reported here a 19-year-old girl was studied for the possibility of patent ductus arteriosus. A No. 7 Cournand catheter was inserted through the left artery under fluoroscopic control. It was passed into

the ascending aorta and, without resistance, was advanced to a point near the right cardiophrenic angle. Pressure recordings indicated an atrial wave form. Ten cubic centimeters of 70 per cent Diaginal was injected, visualizing the right coronary artery. After withdrawing the catheter tip to 3 cm. above the aortic valve and a 10 minute wait, 30 c.c. of medium was injected, producing a thoracic aortogram and again filling the right coronary artery. Subsequent cardiographic progress indicated a posterior myocardial infarction. There was, however, apparent clinical recovery.

The present report indicates and reemphasizes the dangers of retrograde aortic catheterization. Of practical import is the possible misleading information afforded by pressure recordings during the procedure. The authors question the propriety of searching for the aortic valve orifice or of any other exploration by retrograde aortic catheterization in the region of the valve.

Two roentgenograms; 4 pressure tracings; 4 electrocardiograms.

JOHN F. RIESSER, M.D.  
Springfield, Ohio

**Gangrene of the Large Intestine and Ovaries after Translumbar Aortography. Report of a Case.** Charles Fineberg, David C. Schechter, and Claude W. Barwick. *J.A.M.A.* 167: 1232-1236, July 5, 1958. (1025 Walnut St., Philadelphia, Penna.)

The authors report a single case of concomitant thrombosis of the mesenteric and ovarian vessels following translumbar aortography.

The patient was a 58-year-old woman who entered the hospital for a probable Leriche's syndrome. To confirm this diagnosis, translumbar arteriography was done: 35 c.c. of 70 per cent sodium acetate (Urokon Sodium) was injected through a No. 17 aortography needle at the level of the second lumbar vertebra in divided doses of 5 and 30 c.c. Films were obtained and the patient was returned to her room in good condition.

Within the next twenty-four hours lower abdominal pain, melena, and abdominal distention developed. Emergency exploratory laparotomy showed the lower aorta to be thickened and sclerotic, with no palpable pulsation. There was thrombosis of the superior left colic and mesenteric arteries, with gangrene of the entire distal colon from the distal transverse colon to and including the rectum. Both ovaries and the right fallopian tube were necrotic. Bowel resection was performed, as well as left oophorectomy and right salpingo-oophorectomy, and the patient made a satisfactory recovery. A large quantity of contrast medium was found in the intestinal wall.

It is considered likely that in this case the needle lifted a sclerotic plaque from the aortic wall and a false lumen was created outside the aorta, with eventual thrombosis of the affected vessels.

There follows a discussion of possible predisposing factors to vascular thrombosis following aortography, namely, (1) too great an injection pressure, (2) too large a volume of contrast material, (3) the use of too toxic or irritating a contrast material. It is suggested that multiple injections in the region of the orifices of the mesenteric vessels, that is, L-1 to L-3, and the use of inorganic iodides also predispose to complications. It must be noted that even the organic iodide solutions are not free from possible danger.

Three roentgenograms; 1 table.

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Quincy, Mass.



## THE BREAST

**A Roentgenographic Study of the Growth Rate of 6 Early Cancers of the Breast.** Helen Ingleby, L. Moore, and J. Gershon-Cohen. *Cancer* 11: 726-730, July-August 1958. (H. I. Einstein Medical Center, Northern Division, Philadelphia 41, Penna.)

The authors report 6 cancers found in a series of over 4,000 roentgenographic examinations of the breast which received unintentionally delayed treatment ranging from four months to four years. All patients were under close clinical supervision. Five patients had a total of 7 previous surgical interventions for benign breast lesions, 4 of them in the breast in which the neoplasm was later discovered. Roentgenographic studies were made at the time of the patient's first visit and again shortly before operation. At surgery, only 2 of the cancers were clinically palpable and only 1 patient had axillary metastases.

In retrospect, all of the tumors could be visualized on the first films and furthermore all showed at least one of the signs that the authors have since learned to associate with a roentgenographic diagnosis of carcinoma. Therefore, even in those cases coinciding with the current definition of early cancer in which the tumor was not palpable and the lymph nodes free of growth at surgery, neoplasm had been present for a considerable period.

The tumor outlines were traced on squared paper, and the average rate of tumor growth per month was estimated. A carcinoma *in situ* did not grow during the period of observation. Two duct carcinomas and 2 circumscribed carcinomas grew slowly, increasing in size at rates of approximately 3 to 5 per cent per month. Rapid growth occurred in a scirrhous carcinoma with 29 per cent increase per month. If the paths of growth during the period of observation were traced back along the exponential curves, the duration of the tumors could be estimated. This yielded an estimated fourteen-month period of clinical quiescence for the scirrhous carcinoma, and thirty-seven to forty-seven months for the slowly growing cancers. The authors conclude that even granting that secondary tumor changes may influence clinical detection of a cancer, their figures call for re-evaluation of the current concept of "early" breast cancer, and the role played by clinical examination in its detection.

Four figures, including 2 roentgenograms; 1 table.

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## THE DIGESTIVE SYSTEM

**Pathology of a Lower Esophageal Ring; Report of a Case, with Autopsy, Observed for Nine Years.** H. Edward MacMahon, Richard Schatzki, and John E. Gary. *New England J. Med.* 259: 1-8, July 3, 1958. (H. E. M., Tufts University School of Medicine, Boston, Mass.)

The authors present the first autopsy report of a patient with a symptomatic lower esophageal ring, in whom a roentgenologic diagnosis had been established and repeatedly confirmed over a period of nine years. The lesion, seen roentgenologically as a narrow, deep, annular indentation in the lumen of a distended lower esophagus, was found at the junction of the esophageal and gastric mucosa. It appeared as a nearly

symmetrical circular wedge-shaped shelf or diaphragm that protruded from the wall into the lumen in a plane that was almost vertical to the long axis of the esophagus. It represented little more than a mucosal fold covered above by squamous-cell mucosa and below by gastric mucosa. A delicate annular ring of smooth muscle encircled this fold immediately beneath the epithelium covering the innermost free margin. The anatomic construction of this diaphragmatic wedge, or lower esophageal ring, offers a reasonable basis for therapy through simple rupture.

Many antemortem and postmortem roentgenograms along with photographs of the gross specimen and photomicrographs are reproduced.

RICHARD A. ELMER, M.D.  
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**Peptic Esophagitis Simulating the "Postcholecystectomy Syndrome."** A. I. Friedman. *Ann. Int. Med.* 49: 120-129, July 1958. (405 State St., Hackensack, N. J.)

The finding of cholelithiasis or nonvisualization of the gallbladder does not necessarily mean that the patient's symptoms are due to gallbladder disease, and a "postcholecystectomy syndrome" may in some instances be a result of inadequate preoperative investigation. Cholecystectomies have been performed without benefit because the complaints were actually due to peptic (reflux) esophagitis. The frequency of the association of gallbladder disease and duodenal ulcer is well known, as is the fact that symptoms are often due to the ulcer rather than to the gallbladder. On the other hand, the association of hiatus hernia with esophagitis and gallbladder disease has not been stressed adequately.

Four cases are reported in which cholecystectomy was performed for cholelithiasis without relief of symptoms. In 1 patient, subsequent sphincterotomy on a presumptive diagnosis of biliary dyskinesia also failed to relieve symptoms. Barium study from one to eight years later revealed hiatus hernia with esophagitis in each of the 4 patients. Medical therapy produced symptomatic relief in 3, while 1 required surgical intervention.

The author concludes that peptic esophagitis may be responsible for the symptoms of a patient with calculous disease of the gallbladder whenever heartburn and sour regurgitation appear prominent in the clinical picture. "In these patients the decision to operate for gallbladder disease should be an indication for barium-meal study. The high incidence of silent calculous gallbladder makes such clinical investigation mandatory to avoid some of the failures of gallbladder surgery."

Seven roentgenograms.

CHARLES M. GREENWALD, M.D.  
Iowa City, Iowa

**Sideropenic Dysphagia.** T. H. Bothwell and R. Glyn Thomas. *South African M. J.* 32: 614-617, June 14, 1958. (University of the Witwatersrand, Johannesburg, Union of South Africa)

A case is described in which iron deficiency caused marked epithelial changes (glossitis, esophageal stricture, and koilonychia) but no anemia. On barium swallow, an upper esophageal stricture was shown, in the form of a web projecting into the lumen, mainly from the anterior wall. On deglutition the esophagus



above the constriction bulged out to form a pseudo-diverticulum or pouch. In the anterior position, barium from both pyriform fossae was diverted to the left and the stricture was again seen about 1 1/2 inches below the cricopharyngeus. For a short distance below this the esophagus appeared narrowed and slightly irregular. A web may easily be missed on routine examination and in this case a special technic was used for the barium-swallow examination. This calls for a rapid-acting spot-filming device and exposures of no more than a tenth of a second if a sharp radiographic image is to be obtained.

Dysphagia, which was the most prominent symptom of the case, was treated by esophageal dilatation and intramuscular iron therapy, with good results.

Three roentgenograms.

**Giant Gastric Ulcers.** Isidore Cohn, Jr., and Jack Sartin. *Ann. Surg.* 147: 749-758, May 1958. (Department of Surgery, Louisiana State University School of Medicine, New Orleans, La.)

Thirty-five patients with gastric ulcerations measuring over 2.5 cm. were seen in a large general hospital during a period of six years. Thirty-two had benign ulcers and 3 malignant.

Gastrointestinal roentgen examinations were carried out on 24 patients. Five patients did not have barium studies because of perforations, and 6 because of bleeding. The overall accuracy of the radiologic diagnosis was only 33 per cent. In 5 of the 24 patients an ulceration was not reported from the radiographic study. In 7 of the other 19 the roentgen and pathologic diagnoses were in agreement. In 11 patients the radiographic impression was of a malignant ulcer, while the pathologic examination showed the lesion to be benign. In 1 patient an ulcer proved malignant pathologically was considered benign radiographically.

The symptoms, physical findings, and laboratory studies in this series did not appear to be of specific significance in differentiating the benign from malignant ulcerations. The 3 malignant ulcers were found in males of fifty-eight and seventy years of age and a female of twenty-nine years. The chief complaint of each was pain. The duration of the pain was five and one-half years in one male and fourteen years in the other.

Seven figures; 6 tables.

DEAN W. GEHEBER, M.D.  
Baton Rouge, La.

**Multiple Syphilitic Ulcers of the Stomach and Duodenum. A Case with Unusual Luetic Manifestations.** Hans H. Bassøe. *Am. J. Roentgenol.* 80: 57-59, July 1958. (Bergen Kommune, Sykehuset, Med. Afd. B, Bergen, Norway)

This case report concerns a patient with tertiary syphilis of forty years duration. In addition to tabes dorsalis and severe tabetic arthropathy, he at one time had a large ureteral calculus, which passed without pain into the bladder.

Twenty-five years after acquiring syphilis the patient had melena and was found to have a duodenal ulcer. Fifteen years later melena again occurred and three gastric ulcers and one duodenal ulcer were demonstrated roentgenologically. Gastric acidity was normal and there were no dyspeptic symptoms.

On antisyphilitic treatment the ulcers decreased in size, and it seemed most likely that they were of

syphilitic origin. The x-ray appearance of the lesions was not striking or specific.

Ten roentgenograms. DON E. MATTHIESEN, M.D.  
Phoenix, Ariz.

**Gastric Leiomyoma.** G. A. Medhurst. *Brit. J. Radiol.* 31: 372-376, July 1958. (Department of Radiology, General Hospital, Kettering, England)

In this report of 15 cases, the subject of gastric leiomyoma is thoroughly discussed, especially with reference to the radiographic features.

The tumors may or may not be polypoid, and they may or may not be pendunculated or ulcerated. Consequently, they do not have a constant roentgen appearance. A rounded, polypoid tumor, however, is suggestive, and the presence of an ulcer crater in such a tumor, with a long history of anemia or hematemesis, is strongly in favor of leiomyoma.

The author describes a double-contrast technic for examination whereby air inflation is carried out through a stomach tube after introduction of a small amount of barium suspension. In the Trendelenburg position the barium gravitates into the fundus to outline any tumor which may be present in that region. This method is too time-consuming for routine use but is recommended for repeat studies when a tumor is known to be present and further information is desired.

In 15 cases reported here a gastric tumor was seen in all but 1. In that case the tumor was located at the pyloric canal. In 6 cases leiomyoma was diagnosed radiologically; in 3 cases the x-ray diagnosis was "benign tumor"; and in the remainder the appearance did not permit malignancy to be ruled out.

Four roentgenograms; 2 tables.

DON E. MATTHIESEN, M.D.  
Phoenix, Ariz.

**Eosinophilic Granuloma of the Stomach. Report of a Case.** Walter Koch, Edgardo Stockmeyer, and Hernan Apablaza. *Am. J. Roentgenol.* 80: 54-56, July 1958. (W. K., Casilla 1537, Valparaiso, Chile)

Gastric eosinophilic granuloma may form on an allergic basis, and is frequently associated with mucous colitis, vasomotor rhinitis, or urticaria. Depending somewhat upon size and duration of the lesion, there may be eosinophilia, gastric pain, anorexia, or weight loss.

Pathologically the growth begins in the submucosa, and is thought possibly to follow upon a period of reticular proliferation. The size may vary from that of a cherry to that of a small orange.

Roentgenologic findings are variable, but there usually is an antral filling defect whose border is characteristically sharply defined. Benign polyps, aberrant pancreatic rests, adenomyoma, and other neoplasms may produce a similar appearance.

A case is reported which is believed to be the first one observed in Chile.

Five roentgenograms; 3 photomicrographs.

DON E. MATTHIESEN, M.D.  
Phoenix, Ariz.

**Pseudotumors of Gastric Antrum in Pernicious Anemia. Report of a Case.** Robert S. Nelson and Dionisio S. J. Salvador. *J.A.M.A.* 167: 1487-1489, July 19, 1958. (University of Texas M. D. Anderson Hospital and Tumor Institute, Houston, Texas)

A 67-year-old male was admitted to the hospital complaining of weakness. Prior to admission, an

upper gastrointestinal series was reported as showing carcinoma of the stomach. An initial hemogram revealed 6.2 gm. hemoglobin and a red blood cell count of 2,000,000. Bone marrow aspiration was done and the findings were interpreted as indicative of pernicious anemia. No free acid was found on gastric analysis. Roentgen examination on admission was reported as showing "carcinoma of the antrum with shallow ulceration and extension along the stomach wall, to well above the incisura angularis." A second examination, twenty-one days later, showed "irregularity and rigidity of the walls of the distal antrum, extending proximally" and again the conclusion was carcinoma. A gastric washing was negative for abnormal cells. Gastroscopy revealed atrophy of the gastric mucosa but no evidence of tumor or ulcer. The patient was given vitamin B<sub>12</sub> and improved rapidly. Laparotomy was performed and no tumor was found, though the mucosa was studded with mucus-containing cysts. Biopsy showed no evidence of malignancy. A follow-up gastrointestinal series two months later disclosed only hypertrophy of the mucosal folds.

The authors note that there are no reports of pseudotumors in cases of untreated pernicious anemia in the recent literature. Several such cases, however, were recorded prior to 1935.

Three roentgenograms.

J. S. ARAJ, M.D.  
Toledo, Ohio

**Intussusception in the Adult.** J. A. Myburgh. South African M. J. 32: 540-543, May 24, 1958. (Coronation Hospital, Johannesburg, Union of South Africa)

Four cases of intussusception in the adult are presented in the body of this article, and a fifth is reported in an addendum. While most writers place the incidence of this condition in adults at 5 per cent of intussusception at all ages, the author believes it may be of more common occurrence.

The precipitating lesions in the present series varied. In Case IV an ulcerating bilharzial lesion of the cecum formed the apex of the intussusception and at laparotomy closely resembled a malignant ulcer. In Case I the macroscopic appearances were those of a benign small-bowel tumor, but the pathological report was that of nonspecific inflammatory lesion. In Case III the intussusception appeared to be primary. In Case II the etiology remains unknown, as the patient refused operation. In Case V the cause was found to be a polypoid adenoma with mucoid degeneration.

A scout film of the abdomen was normal in only 1 case. In 2 cases there were obvious features of lower small-bowel obstruction, and also evidence of free fluid in the peritoneal cavity. In the fourth case a plain roentgenogram showed evidence of partial small-bowel obstruction. No roentgen data are given for the fifth case.

Barium-enema studies were performed in 2 cases, and the features were pathognomonic, viz., an obstruction to the retrograde flow of barium, a rounded filling defect produced by the apex of the intussusception, and a "coiled spring" effect in the postevacuation films, produced by the insinuation of barium between the returning and ensheathing layers of the intussusception.

Hydrostatic reduction has little or no place in the treatment of the condition in the adult, because few cases are primary. The intussusception should be sur-

gically reduced if possible and the causative lesion dealt with according to the conditions discovered.

Five roentgenograms.

**Calculi in a Meckel's Diverticulum.** John L. Boldero. J. Fac. Radiologists 9: 157-160, July 1958. (United Oxford Hospitals, Oxford, England)

The author reports the case of a 71-year-old man who entered the hospital with acute upper abdominal pain radiating to the back interscapularly. A recumbent film showed a cluster of faceted ring shadows in the pelvis just to the right of the midline. Excretory urography excluded any relationship to the urinary tract. Since there was no concentration of medium within the gallbladder after oral cholecystography, operation was performed. The patient was found to have a single large (1 cm.) gallstone, as well as several smaller stones, within the gallbladder. The calculi noted on the abdominal film proved to lie in a mushroom-shaped Meckel's diverticulum, with a pouch at its distal end measuring some 2 inches in diameter and lined with intestinal epithelium. The calculi were trapped by a valve-like membrane at the base of the pouch. The apex of the pouch was fixed to the mesentery by a fibrous band measuring 8.0 × 2 cm.

The author reviews 16 earlier reports of calculi in Meckel's diverticula. It is well known that small gallstones can be passed into the intestinal tract through the bile passages, and the structure of the calculi in the present case may be construed as indicating that some stones which entered the intestine in this way passed into the Meckel's diverticulum, where they became the nuclei for the larger faceted stones found at operation. From the literature, however, it appears that the fact that the stones in a Meckel's diverticulum may resemble gallstones both radiologically and macroscopically is no indication of their origin.

Two roentgenograms; 2 photographs; 1 table.

SAUL SCHEFF, M.D.  
Boston, Mass.

**Use of a New Micronized Barium (Barotrast) in Roentgen Examinations, with Special Consideration of Double-Contrast Study of the Colon.** A. P. Hoch and S. E. Foster. Schweiz. med. Wchnschr. 88: 730-736, July 26, 1958. (In German) (Röntgeninstitut Dr. Hoch, Zürich, Switzerland)

Barotrast is a micronized barium sulfate powder which has proved to be superior to other barium preparations in the study of the colon. It has been especially helpful in double-contrast barium enemas.

The patients are prepared in the usual way, with a low-residue diet on the preceding day and 2 oz. of castor oil the night before the examination. A cleansing enema is administered in the x-ray department shortly before the barium enema study.

The barium mixture consists of 500 gm. of Barotrast in one liter of water. It is a fairly thick suspension, but it results in uniform coating of the colonic mucosa, which is important for satisfactory double contrast. The gravity method of introducing the enema fluid is not satisfactory because of its thick consistency. Instead a closed system with the aid of air pressure is used, which allows a quick change-over to injection of air.

The usual spot films, especially of the sigmoid colon, are obtained. Supine as well as prone views are necessary for overcoming blind spots and for unfolding of the entire colon. Lateral, oblique, and axial views (Chas-

sard-Lapiné) are occasionally necessary for obtaining the desired information.

This short article is illustrated by impressive double-contrast enema roentgenograms.

ERNEST KRAFT, M.D.  
Northport, N. Y.

**Significance of Fluid Levels in X-Ray Films of the Abdomen.** John K. Donahue, Charles Hunter, and Henry H. Balch. *New England J. Med.* 259: 13-15, July 3, 1958. (Georgetown University Medical Center, Washington, D. C.)

Many surgeons and radiologists believe that the appearance of fluid levels in the intestine on a roentgenogram of the abdomen is pathognomonic of intestinal obstruction. The authors report an investigation which showed that this view is erroneous.

Twenty-three young female patients who were hospitalized but who had no clinical indication of any abnormality of the gastrointestinal tract were studied. Films obtained in the upright position one and two hours after oral administration of 30 or 40 gm. of magnesium sulfate in a glass of warm water showed a fluid level in every instance. Control films obtained in the upright and supine positions before the administration of the magnesium sulfate revealed no fluid levels.

It is therefore concluded that fluid levels do not necessarily indicate a condition of bowel stasis and are certainly not pathognomonic of intestinal obstruction.

Four roentgenograms.

RICHARD A. ELMER, M.D.  
Atlanta, Ga.

**Roentgen Findings in Cholecystitis.** Eva Gaebel and W. Teschendorf. *Radiol. clin.* 27: 227-233, July 1958. (In German) Strahleninstitut der Allgemeinen Ortskrankenkasse, Cologne, Germany)

In the presence of an inflammatory process in the gallbladder, one may expect (1) faint or absent visualization of the gallbladder, whether the contrast medium was given by mouth or intravenously; (2) incomplete or no contraction of the gallbladder after a fatty meal; (3) periduodenal adhesions, visible after ingestion of a barium meal; (4) absence of the initial layering usually seen on the first upright view after injection of Biligrafin ("normally" the liver bile is thinner than gallbladder bile, therefore layering occurs; absence of layering would mean that the gallbladder bile is not concentrated, i.e., there are disturbances of resorption in the gallbladder); (5) spot-tenderness of pressure over the gallbladder fundus. This last sign is considered to be of paramount significance and would imply the desirability of fluoroscopic examination after peroral and intravenous administration of either a cholecystographic or cholangiographic medium. In the absence of visualization of the gallbladder, tenderness should be evaluated by palpation during upper gastrointestinal examination with barium, spot pressure being applied just lateral to the location of the duodenal cap as seen in a strictly frontal projection.

Six roentgenograms.  
E. R. N. GRIGG, M.D.  
Cook County Hospital, Chicago

**A Review of the Current Status of Nonoperative Cholecystoangiography.** Edwin M. Cohn and David M. Sklaroff. *Arch. Int. Med.* 101: 1051-1056, June 1958. (1315 Tabor Rd., Philadelphia 41, Penna.)

The outstanding contribution of cholecystoangiography

with iodipamide (Cholografin) is the ability to demonstrate the biliary tract after cholecystectomy to determine whether symptoms which persist are associated with disease of the ductal system. Much of the confusion concerning the postcholecystectomy syndrome has been clarified by the use of this procedure. Preoperatively it may be employed to determine the presence of calculi in the common duct and to visualize the gallbladder after unsuccessful attempts with orally administered media.

The advantages of the technic and its limitations are reviewed, with numerous references to the literature, but no personal experience on the part of the authors is cited.

**Intravenous Cholangiography in Children with Fibrocystic Disease of the Pancreas. A Pilot Study.** Malcolm D. Jones, Hsajiq Sakai, and Alexander G. Rogerson. *J. Pediat.* 53: 172-179, August 1958. (University of California School of Medicine, San Francisco 22, Calif.)

Sixteen patients with proved mucoviscidosis (pancreatic fibrosis) and a single control were studied by means of intravenous cholangiography. The children ranged in age from nineteen months to eleven years, 10 being seven years old or older. Dosage consisted of 1 c.c. of Cholografin per 2 kg. of weight to a maximum of 20 c.c. Films taken included tomograms in the anteroposterior position for assessment of intrahepatic detail.

Two patterns of the intrahepatic radicles were observed: (1) "broad" and somewhat tortuous and (2) "narrow" and spread. Those patients in whom the diagnosis was established at an early age tended to show a broad pattern. The significance of this relationship was not apparent, nor was it clear whether such a pattern difference did in fact exist or whether it might represent only different phases of the disease.

The degree of opacification of the biliary duct system could not be correlated entirely with the width of the ducts as measured on the films. This may be explained in part as the effect of specific gravity, with collection of the medium in the more dependent portions of the duct, in a fashion similar to the layering phenomenon observed in the gallbladder with Cholografin. The original consideration that the common duct might show some change in its pancreatic portion could not be established.

From the technical standpoint, the authors consider two features interesting. One is the rapidity of excretion, the biliary radicles being well demonstrated twelve minutes after injection. The other is filling of the gallbladder, which occurred in 13 of the 16 patients studied. This was rather unexpected in view of the pathologic pattern usually found at autopsy, with the gallbladder small or empty, or containing inspissated bile.

One table.  
CHARLES M. GREENWALD, M.D.  
Iowa City, Iowa

## THE MUSCULOSKELETAL SYSTEM

**Multiple Epiphyseal Dysplasia.** Herbert Barrie, Cedric Carter, and John Sutcliffe. *Brit. M. J.* 2: 133-137, July 19, 1958. (Hospital for Sick Children, Great Ormond St., London, England)

Multiple epiphyseal dysplasia is an uncommon familial disease characterized by irregular and often retarded ossification of several epiphyses. Symptoms invariably appear in childhood, but most adults cannot recall the

time of onset. The degree of disability is variable but may be severe, with recurrent attacks of joint pain and stiffness. Eventually osteoarthritis [traumatic arthritis?—J. W. B.] may lead to marked limitation of movement.

Clinically the most commonly involved joints are those subject to weight-bearing, particularly the hips and knees. Radiologically the changes are often best demonstrated in the hands, wrists, and ankles. It is noted that signs and symptoms tend to be remarkably similar in members of the same family but vary considerably from one family to another. Patients are usually of short stature, but pronounced dwarfism is rare. The fingers are stubby, and the affected epiphyses are often enlarged.

Radiographic findings are not always obvious, and incorrect diagnoses are common. Attention to the following points has been thought to be of most use diagnostically. Wrist and hand roentgenograms show small, irregularly shaped carpal bones, usually with delayed ossification of the carpal centers. The central parts of the radial and ulnar epiphyses are thinner than normal, so that in adult life the lower ends of radius and ulna form a distinct V. There is marked thinning, also, of the lateral part of the lower tibial epiphyses during childhood, leading in adult life to a characteristic downward inclination of the ankle joint from the lateral to the medial side. The femoral and tibial condyles are square and angular. The lower end of the femur is flat, and the intercondylar notch shallow. The femoral heads may be absent, grossly deformed, irregularly ossified (as in Perthes disease), or normal. Involvement tends to be bilaterally symmetrical but is not always so.

Three families in which 15 members were affected are reported, with presentation of family trees and characteristic roentgenograms. Short case histories are given for 3 individuals and symptoms and signs in all 15 are recorded in a table.

Although the pathological basis of the condition cannot be influenced in any way, it is of interest that those patients who received physiotherapy, particularly in early life, experienced considerable relief at the time and suffered less disability later.

Four roentgenograms; 2 photographs; 1 table.

JAMES W. BARBER, M.D.  
Cheyenne, Wyo.

**Osteomyelitis as a Complication in Urology with Special Reference to the Paravertebral Venous Plexus.**  
C. Q. Henriques. *Brit. J. Surg.* 46: 19-28, July 1958.  
(London, England)

The anatomy of the paravertebral venous plexus is described and illustrated, particular attention being called to the rich anastomoses that this plexus forms with the venous channels in and around the vertebral bodies. The literature is reviewed and the important data on all previously published cases of osteomyelitis associated with urinary tract infections are tabulated. Of the 55 cases, all but 11 followed operation on the urinary tract, chiefly the urethra, prostate, and bladder. Half of the bone lesions involved the lumbar spine, one-third the dorsal spine, and the remainder the cervical spine, hip joint, shoulder joint, sternoclavicular joint, sacroiliac joint and tibia. The common infecting organisms were *Staph. aureus*, *E. coli*, *P. pyocyaneus*, and *Proteus vulgaris*.

The author reports in moderate detail 6 illustrative

cases of his own with selected roentgenograms. Five followed operations on the lower urinary tract and 1 occurred spontaneously in the presence of urinary infection. Three patients showed involvement of the spine alone, 1 of the hip bone and 1 of the shoulder alone, while 1 had successive infections in the spine, pubis, and hip.

Osteomyelitis developing as a complication of urinary tract infection occurs usually in patients in poor general health. It is theorized that bacteremia develops following operation and gives rise to a more or less prominent febrile episode one or two days after surgery. The osteomyelitis becomes apparent several weeks later, as pain in the involved area.

The importance of repeated radiographic examinations is stressed, as the findings may change rapidly. In the spine the earliest feature is a narrowing of the disk space followed by loss of trabeculation and rarefaction of the adjacent vertebral bodies. Later a definite cavity appears and thereafter there may be complete or partial collapse of the vertebral bodies with possible compression of the spinal cord. Lateral bony bridging develops as the process heals. Changes in the hip joint begin with narrowing of the joint space and rarefaction of the femoral head, with complete destruction of the latter structure in most cases, and subsequent healing with new bone formation. The average time required for healing in the cases reviewed was between six and seven months.

A discussion of etiology includes comments on the similarity of osteomyelitis of this type to osteitis pubis occurring in association with prostatic infection and surgery. It is theorized that infecting organisms enter the paravertebral venous system, producing local zones of thrombosis and blood stasis followed by a low-grade osteomyelitis.

Ten roentgenograms; 1 photograph; 6 diagrams; 3 tables.

JAMES W. BARBER, M.D.  
Cheyenne, Wyo.

**Scleroderma Associated with Osteopoikilosis.**  
Gerald Weissmann. *Arch. Int. Med.* 101: 108-113, January 1958. (350 Central Park West, New York, N. Y.)

The case is reported of a 35-year-old soldier in whom scleroderma and osteopoikilosis were found to exist simultaneously. In addition to the classical lesions of scleroderma clinically, this patient had areas of soft-tissue calcification near the proximal interphalangeal joint of the second finger and the interphalangeal joint of the thumb of the right hand. At the epiphyseal and adjacent metaphyseal ends of all bones, large and small, the lesions of osteopoikilosis were readily discernible radiographically. It was difficult to relate the manifestations of intra- and extraskelatal calcifications in this patient without speculation as to the concurrence of scleroderma and osteopoikilosis.

That patients with scleroderma have an associated disturbance of calcium metabolism has long been suspected. The incidence of calcinosis in this condition has been estimated as 10 per cent. Careful calcium-balance studies, however, are not too numerous. The author's patient was in negative calcium balance while at relative bed rest, excreting 490 mg. Ca per seventy-two hours with a 390 mg. per seventy-two hours intake.

The parathyroids have been repeatedly associated with scleroderma. Relief of symptoms has been reported following parathyroidectomy, and administration of parathyroid hormone has been said to result in



sclerodermatous lesions in rabbits. Whether such a pathogenetic mechanism exists in the production of the intraskeletal calcifications of osteopoikilosis is as yet unanswerable. No disorder of calcium metabolism has been associated with this condition, and what few laboratory determinations have been reported were within the normal range. "It may be that the increased tendency to calcification, if present at the time of early bone formation, manifests itself first as osteopoikilosis and only later as the calcinosis of scleroderma. Only a long-range study of both diseases, with associated calcium-balance studies, could test this hypothesis."

Five roentgenograms; 3 photographs.

**Rheumatoid Spondylitis: Manifestations and Management.** Aaron M. Lefkowitz and J. R. Thomas. *Ann. Int. Med.* 49: 89-101, July 1958. (A. M. L., VA Medical Teaching Group Hospital, Memphis 15, Tenn.)

The authors describe the clinical features and rheumatologic signs in 267 patients with rheumatoid spondylitis. The youngest patient was seventeen years old at onset, and the oldest fifty-four. Over 50 per cent of the group were in the third decade. Subjective complaints of peripheral joint involvement were present in 63 per cent; objective signs of peripheral involvement in 42 per cent; sciatic radiation in 24 per cent.

It is generally known that subjective manifestations of rheumatoid spondylitis may make their appearance long before definite evidences of the disease are seen by x-ray, and this interval may vary from a few months to years. A greater difficulty is the recognition and correct interpretation of the early x-ray changes caused by disease in the sacroiliac joint and particularly in the small diarthroidal joints of the vertebral column. The authors found inclined views of the sacroiliac joints and oblique views of the spine helpful in this respect.

All patients in the series had roentgen evidence of involvement of the sacroiliac joints. Changes were varied and included narrowing or widening of the joint spaces, irregular and indistinct joint margins, at times with serrated edges, partial or complete obliteration of the joint spaces, and spotty osteoporosis and irregular sclerosis of the adjacent sacrum and/or ilium. Calcification of spinal ligaments was recognized in 33 per cent of the patients, the degree and extent varying markedly. The hip joints were involved in 15 per cent.

The difficulties in diagnosis encountered in the early stages of this disease are discussed. A feature which the authors found of diagnostic value is aching in any part of the back in a young man, occurring often during the night and inducing him to get off the bed to "limber up." They mention also careful evaluation of results of leg and spinal maneuvers, particularly the flexibility or rigidity of the spine on body movements, and meticulous examination of roentgenograms of the sacroiliac joints.

Irradiation was only one of several therapeutic measures employed and no separate evaluation of this procedure was attempted. Relief of subjective complaints occurred not infrequently two to four weeks after completion of irradiation. The best results were generally obtained from a combination of physiotherapy, irradiation, postural and muscle exercises, the judicious use of aspirin, and correction of static factors and of established deformities by orthopedic procedures.

Two graphs; 5 tables.

CHARLES M. GREENWALD, M.D.  
Iowa City, Iowa

**Non-neoplastic Sclerosis in Vertebral Bodies.** W. Ackermann and G. S. Schwarz. *Cancer* 11: 703-708, July-August 1958. (G. S. S., Columbia University College of Physicians and Surgeons, New York 32, N.Y.)

In a search for metastases, biopsy was done on the vertebrae of 340 patients (339 with carcinoma and 1 suspected to have cancer), by means of a special trephine. Osteosclerosis was demonstrated microscopically in 28, and in 13 of these the sclerosis was non-neoplastic. This osteosclerosis was evident radiographically in 17, and in 5 of this number the affected vertebra was free of cancer cells. Thus, nearly 40 per cent (5 of 13) of the histologically proved non-neoplastic osteoscleroses were demonstrated radiologically, the films revealing circumscribed sclerosis in the region of biopsy.

This form of sclerosis affected only adults, was localized rather than systemic, and involved only a segment of the vertebral body. The etiology is unknown, and it has not been established whether the process begins in the cortex or in the marrow.

The authors believe that this is a hitherto unreported condition. It appears to be distinct from the type of vertebral sclerosis that Schmorl and Junghans thought to be caused by disk disease, because neither clinically nor radiographically was there any evidence of such an occurrence. Moreover, in one case autopsy revealed absence of disease in the intervertebral space above and below the affected vertebra.

Brief radiologic consideration is given other conditions producing vertebral sclerosis. These include osteopetrosis, osteopoikilosis, changes due to infection, chemicals, and trauma, Paget's disease, dense bone islands, osteoid osteoma, myelofibrosis, radiation necrosis, osteophytes, and metastases. The authors believe that the clinical importance of the entity which they describe lies in the fact that the lesion is usually mistaken for one or another of the aforementioned forms of osteosclerosis, particularly osteoblastic metastases. Patients may thus be treated with radiation or hormones, and needlessly penalized. Trephine biopsy has proved to be a satisfactory method of differentiating this form of osteosclerosis from other lesions of the vertebra.

The roentgenologic and histologic findings in 2 cases are reported in detail.

Four roentgenograms; 2 photomicrographs.

CHARLES M. GREENWALD, M.D.  
Iowa City, Iowa

**Esophageal Obstruction Due to Lesions of the Cervical Spine.** Howard A. Patterson and Grimes Byerly. *Ann. Surg.* 147: 863-866, June 1958. (H. A. P., 1160 Park Ave., New York 28, N. Y.)

The authors report a case of a large bony mass involving the anterior aspects of the bodies of the fifth and sixth cervical vertebrae and impinging on the posterior wall of the cervical esophagus so as to interfere with swallowing. The patient was a fifty-seven-old male with a considerable weight loss because of steadily increasing dysphagia for a period of several months. Surgical removal of the mass resulted in complete relief of symptoms and return of the esophageal lumen to normal caliber.

The condition, termed by the authors, vertebral osteophytosis, had the appearance of advanced spondylosis deformans. The authors point out that serious injury to the esophagus is likely to occur during esoph-



agoscopy unless the endoscopist is aware of the presence of such an abnormality in the spine. Lateral roentgenograms of the cervical esophagus are essential for establishing the diagnosis.

Three roentgenograms. HARRY HAUSER, M.D.  
Cleveland Metropolitan General Hospital

**Slight Myelographic Deformities in Sciatica.** L. Walk. Acta radiol. 50: 226-229, July-August 1958. (Centrallasarettet, Eskilstuna, Sweden)

The author reports a study of 143 cases of sciatica with particular attention to slight myelographic deformities and their relation to intervertebral disk changes. The patients were examined by both diskography and myelography. On the basis of the diskographic findings, four groups were recognized: (A) normal; (B) disk rupture, without or with only slight widening of the nucleus pulposus; (C) degenerated disks with a widened nucleus pulposus; (D) degenerated disk with rupture.

The myelographic observations in the different groups are described and illustrated. In Group B (disk rupture) diffuse swelling is frequent, especially in the first four months of the condition; later the nerve root may frequently become normal.

In Group C (degenerated disks), conical widening of the nerve root localized to the disk level is seen, and possible shortening of the root pocket. These changes are secondary to disk pressure. A combination of widening and swelling may be seen in this group and in Group D.

Recognition of slight myelographic changes permits localization of the pathologic disk, offers a hint as to the age of disk rupture [not explained], and indicates the nature of the disk lesion and degree of root change. Sciatica caused by other factors than disk lesions may be identified by myelographic root deformities in the presence of a normal diskogram.

Six roentgenograms; 1 table.

JOHN C. POWERS, M.D.  
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**Epidural Pneumomyelography.** J. Kohout. Acta radiol. 50: 217-220, July-August 1958. (Neurological Department, Strakonice Hospital, Czechoslovakia)

Normal air myelograms may sometimes be usefully supplemented with epidural air studies. Proper entrance into the epidural spaces may be achieved by first performing a normal lumbar puncture with the patient on his side, withdrawing 30 to 60 ml. of cerebrospinal fluid, and then retracting the needle carefully until the flow ceases. At this point 40 to 100 c.c. of air is injected into the spinal canal. Following the air injection anteroposterior and lateral films are made in the conventional manner, and two anteroposterior views are also obtained with a horizontal beam (decubitus views).

The author states that, although the method is generally less useful than subarachnoid air myelography, it will show L5-S1 disk protrusion better. The cervical meninges or contour of the dural sac elsewhere may be demonstrated very well when the two procedures are combined.

No complications have been observed, and if air is not allowed to reach the skull there will be no headache. Experience with 20 cases is related.

Three roentgenograms.

DON E. MATTHIESEN, M.D.  
Phoenix, Ariz.

**Cyst-Like and Cystic Lesions of the Rib with Special Reference to Their Radiological Differential Diagnosis Based on the Discussion of Five Cases.** Karl Mendl and Cyril J. Evans. Brit. J. Radiol. 31: 146-155, March 1958. (Morrison Hospital, Swansea, Wales)

A cyst-like circumscribed unilocular or multilocular area of translucency in a rib is not characteristic of any specific lesion, and it is impossible to say from the roentgenogram whether the bone loss is due to neoplastic, vascular, fibrous, or granulomatous tissue, or to fluid as in parasitic cysts. The radiological appearance of lesions of the rib is partly or entirely due to the reparative process of the bone in response to the injury. This explains the similarity of the roentgen picture in various pathological conditions. In the course of the progression of the lesion there occur certain features such as perforation of the cortex, periosteal reaction, transgression of the periosteum with extension beyond the bone, and formation of a soft-tissue mass, radiological signs which help to restrict the possibilities by the process of elimination, or make a conclusive diagnosis possible.

The authors discuss the various lesions which can produce cyst-like changes in ribs and report 5 cases, each representing a rare condition.

**Hemangioma of the Rib:** A cyst-like appearance due to vascular tissue is illustrated by a case of hemangioma of the rib, which is believed to be the ninth such case recorded in the literature. The radiologic picture differs from the sunray trabeculation usually seen in hemangioma of flat bones, showing instead the soapbubble appearance described as characteristic of hemangioma of long bones. The authors agree with Hadders and Oterdoom (J. Path. & Bact. 71: 193, 1956) that the "aneurysmal bone cyst" is identical with hemangioma of bone and represents only a special variety.

**Solitary Plasmacytoma of the Rib and Single Metastatic Neuroblastoma of Rib:** The multilocular appearance due to neoplastic tissue is demonstrated by 2 cases. One was a solitary plasmacytoma of the rib, the third case to be reported. Early radical treatment is advocated for such cases on the presumption that metastatic dissemination is a possibility. The other case was a solitary metastatic neuroblastoma of the rib. The patient was well for six years following diagnosis and treatment until another metastasis developed.

**Hydatid Disease of the Rib:** The case of hydatid disease of the rib is the only example of a true cystic lesion. The hydatid broke through the cortex and periosteum into the pleural cavity and eroded a thoracic vertebra.

**Lipoid Granuloma of the Rib:** A case of lipoid granuloma of the rib is described which showed circumscribed bone destruction produced by granulomatous tissue. It was a solitary manifestation of Hand-Schüller-Christian disease without craniopharyngeal localization.

Thirteen roentgenograms; 1 photograph; 5 photomicrographs.

**Concerning Acro-Osteosclerosis.** P. Deák. Fortschr. a. d. Geb. d. Röntgenstrahlen 89: 59-66, July 1958. (In German) (Hauptstädtisches "Tetényi"-Krankenhaus, Budapest, Hungary)

Acro-osteosclerosis, or condensation of bone occurring in the terminal phalanges of the fingers, is an asymptomatic condition and therefore has received but little attention in the literature. The author differentiates between the spotty and the diffuse types. The changes are mainly seen in the distal phalanges of the fourth and

fifth fingers and less often in the middle and index fingers. There is frequently bilateral symmetric involvement, with an ulnar distribution of the lesions. When, in addition to the distal phalanges the middle and/or proximal phalanges are involved the roentgen findings may simulate localized melorheostosis. Histologic findings are similar to those of osteopetrosis and Engelmann's disease, with endosteal proliferation of bone.

In 400 consecutive patients, 272 females and 128 males, the condition was found in 54 (13.5 per cent). There were 37 diffuse cases, all in females, and 17 spotty cases, only 3 in which were in males. From this observation it is concluded that the condition occurs almost exclusively of females and can be expected in every fifth woman of middle age subjected to roentgen study of the hands.

The fact that females of menopausal age are chiefly affected suggests an endocrine imbalance as a pathogenetic factor. Folliculin is known to play a role in the formation of bone structures. Therefore, hormonal dysfunction with dysmenorrhea, irregular metrorrhagia, and menopausal symptoms treated with estrogens appear to be a plausible explanation for the development of acro-osteosclerosis. Associated internal frontal hyperostosis is frequently observed.

Two cases are briefly cited in females having had hormonal therapy for prolonged periods of time.

Eight roentgenograms.

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## GYNECOLOGY AND OBSTETRICS

**Salpingography: Study of Use of Diatrizoate Sodium (Hypaque).** Karl A. Youngstrom. J. Kansas M. Soc. 59: 308-309, July 1958. (University of Kansas Medical Center, Kansas City 12, Kans.)

The author has found Hypaque 50 per cent satisfactory for salpingography. It is injected under fluoroscopic control, and results are recorded with spot films taken in the anteroposterior projection and in both oblique projections. When the oviducts are patent, the spill into the peritoneal cavity is apparent at fluoroscopy, and the injection is discontinued. The spilled material is gone in a few hours.

The procedure is considered of diagnostic value in studies for tubal patency and uterine pathology. Contraindications are infection, especially in the pelvis, and possible early pregnancy. To avoid the latter possibility the examination should be done in the immediate postmenstrual period.

Although the ovaries are in the primary beam of the x-rays, they receive only 0.5 to 1.5 r in a properly performed examination with modern x-ray equipment. While the chance that this amount of radiation could produce a detectable change in the natural mutation rate seems quite remote, the author warns that the value of the information to be gained from this or any other diagnostic x-ray procedure should be carefully considered before exposing a patient to radiation in the reproductive period of life, especially when the region to be examined contains the gonads.

Four roentgenograms.

**Pelvic Phlebography.** Ricardo Topolanski-Sierra. Am. J. Obst. & Gynec. 76: 44-52, July 1958. (University of Uruguay, Montevideo, Uruguay)

Two methods of opacification of pelvic veins are

presented. In one of these, used in 10 of the author's series of 70 cases, 20 c.c. of Urografin or Hypaque is injected into the pubic bone 1 cm. from the upper border and 1 cm. from the symphysis, through a 17 B-D needle, in ten seconds. A roentgenogram of the pelvis is obtained at the end of the injection. The second method, and the one to be preferred, consists of injection into the uterine fundus. The tip of a uterine cannula is placed in contact with the fundus, and 20 c.c. of the opaque medium is introduced through a needle 2 to 3 mm. longer than the cannula, following a preliminary injection through the same needle of 150 units of hyaluronidase in 1 c.c. of saline.

The original purpose of the study was the evaluation of pelvic congestion and the visualization of pelvic varicocele. Excellent reproductions of roentgenograms clearly demonstrate uterine fibroids and chronic pelvic inflammation as well.

Thirteen roentgenograms; 1 photograph.

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University of Texas, Houston

**The Importance of the Radiographic Demonstration of Free Gas in the Foetus in the Diagnosis of Intra-Uterine Death.** A. M. Stewart. J. Obst. & Gynaec. Brit. Emp. 64: 915-920, December 1957. (Aberdeen Royal Infirmary, Aberdeen, Scotland)

In the opinion of the author, the radiographic demonstration of free gas in the fetus *in utero* is irrefutable evidence of death. The importance of this finding is apparent from the fact that in 16 cases from the literature and 3 seen by the author it was the only sign of fetal death.

Five cases are reported in which intrafetal gas was observed—in the heart, the great vessels, principally the aorta or vena cava, the liver vessels, and in the umbilical cord. A sixth case is included in which gas was demonstrated in the heart and aorta of a stillborn infant on the day of delivery. The mechanism of the formation of the gas is as yet unknown, but it is considered to consist principally of CO<sub>2</sub> and nitrogen.

In an addendum the author mentions 2 further cases of intrafetal gas—the first observed two weeks and the second ten days after the cessation of fetal movement, with absence of Spalding's sign. From the latter case 0.75 c.c. of gas was obtained from the heart and analysis showed 70 per cent of this to be CO<sub>2</sub> with almost the entire remainder oxygen. No carbon monoxide was present. The pH of the blood was 6.

Seven roentgenograms; 1 table.

**Localization of the Placenta in Suspected Cases of Placenta Previa with the Use of Radio-Active Isotopes (RIHSA).** Nestor R. Canoy. J. Philippine M. A. 34: 302-310, May 1958. (Chong Hua Hospital, Cebu City, P. I.)

The use of radioactive iodinated human serum albumin (RIHSA) was tested as a method of localizing the placental site in cases of suspected placenta praevia. The technic is based on the premise that a greater volume of blood per unit of tissue is present in the placenta than in the surrounding tissue, and therefore the gamma emission of radioiodine which can be picked up by a Geiger counter or scintillation chamber and recorded in a scaler would be greater. Between December 1955 and June 1956, 36 studies were done, including 23 in normal pregnant women. The placenta was localized by both radiographic and isotopic methods.

In 4 cases with an abnormal soft-tissue shadow in the lower segment with displacement of the presenting part on the roentgenogram, isotopic studies confirmed the clinical opinion of absence of placenta praevia. Later the misleading shadow was found in 1 case to be due to a fibroid, and in another to a noncatheterized urinary bladder. In the other 2 there was probably a falling away of the fetus from the uterine wall.

In 9 cases there was clinical suspicion of placenta praevia; in 5, definite isotopic and roentgen evidence of this condition was present, and was confirmed at operation. In 3 cases a marginal placenta praevia was shown to be present. In 1 case where roentgenograms showed a suggestion of a placenta in the anterior abdominal wall near the fundus, to the right, partially obscured by overlying gas and feces, the isotopic count led to the diagnosis of placenta abruptio. This finding was confirmed at premature labor.

The cases diagnosed by isotope counting are still too few in number to warrant a definite conclusion. From the meager data, it can be inferred that the method offers the following distinct advantages: (1) It is simple and innocuous. (2) Its accuracy is comparable to if not superior to the accepted method of localizing the placental site with soft-tissue placentograms. (3) The possibility of errors from artefacts which may simulate a placental shadow on the roentgenograms is ruled out. (4) The method may be superior to soft-tissue placentograms in cases of abruptio placenta. (5) The radiation hazard to mother and fetus is less than with a standard roentgen study. (6) Since not more than 10 microcuries of RIHSA are required for the examination, the cost is low.

Eight figures.

### THE GENITOURINARY SYSTEM

**Clinical Evaluation of Two Recently Developed Urographic Media.** J. N. Taylor and K. W. Ginters. *Ohio State M. J.* 54: 913-914, July 1958. (Ohio State University Hospital, Columbus, Ohio)

One thousand patients undergoing intravenous pyelography were studied in an attempt to evaluate the efficacy and side-effects of Miokon and Hypaque as contrast materials. The medium in each case was selected at random by the nurse and administered by a physician who had no knowledge as to which one was being employed. After a scout film was taken, 30 c.c. of the contrast material to be used was injected intravenously over a period of two to three minutes. Subsequent films were taken five, ten, and fifteen minutes after the administration of the medium.

With the use of Miokon, results were excellent in 230 patients (46 per cent); good in 172 (34.4 per cent); unsatisfactory in 98 (19.6 per cent). With Hypaque results were excellent in 209 cases (41.8 per cent); good in 179 (35.8 per cent); unsatisfactory in 112 (22.4 per cent).

Side-effects occurred in 48 cases (9.6 per cent) examined with Miokon and in 14 of the patients (2.8 per cent) in whom Hypaque was employed. Of the 500 patients in the Miokon series, 84 gave a history of allergy and 15 of these (17.8 per cent) showed side-reactions, as against 7.7 per cent of those in this group who gave no such history. Of 58 patients with a positive history of allergy to whom Hypaque was administered, 6.9 per cent suffered side-reactions as against 2.2 per cent of the allergy-free patients in this series.

**Relationship of Bladder Shadow to Bladder Volume on Excretion Urography.** P. M. Bretland. *J. Fac. Radiologists* 9: 152-153, July 1958. (University College Hospital, London, England)

In 23 unselected normal male patients having normal bladders and no residual urine, the area of the bladder shadow at the end of routine excretion urography, immediately before micturition, was compared with the volume of urine passed. Although there was some qualitative relationship, estimations of the volume of the bladder from the area of its shadow were found to be liable to over 50 per cent inaccuracy. Addition to this series of 16 cases with normal bladder shadows but evidence of residual urine on postvoiding films, and 22 cases with abnormal bladder shadows and in most instances some residuum, did not significantly alter the results.

"It is thus clear," says the author, "without further statistical examination of the data that this method of assessing the volume of urine in the bladder is grossly unreliable. . . . If the volume of residual urine is to be determined radiologically, special techniques must be used."

Three figures.

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Boston, Mass.

### THE ENDOCRINE GLANDS

**The Radiology of Endocrine Disorders. A Symposium. I. The Diagnostic Value of Radiology in Endocrine Disorders.** A. W. Spence. *Brit. J. Radiol.* 31: 341-345, July 1958. (St. Bartholomew's Hospital, London, E. C. 1, England)

The first of three papers in a symposium on endocrine disorders (see following abstracts), this article pays tribute to the usefulness of radiology in diagnosis and evaluation of endocrine disorders.

Pituitary tumors are discussed first, and several points enumerated which help to determine whether they are intrasellar or suprasellar. Intrasellar tumors are generally adenomas and cause a general enlargement of the sella. They may erode the sellar floor, especially in the less resistant posterior portion. Extension upward presses on the interclinoid ligaments, and secondarily pulls the anterior clinoid processes upward. At the same time the anterior clinoid processes become eroded. The posterior clinoids are eroded more slowly. With the suprasellar tumors the sella is wider in the dorsal part where the tumor has forced its way downward through the diaphragm; the anterior clinoids do not point upward; the posterior clinoids are eroded early; and the sella is not usually ballooned.

To determine the size of a pituitary adenoma, ventriculography is recommended when the magnitude of the sellar changes and the extent of the visual disturbances do not appear consistent with each other.

In doubtful early cases of acromegaly, skeletal changes may help make the diagnosis. Along with the usual skull changes and tufting of terminal phalanges, the author mentions fusion of carpal and tarsal bones as a valuable sign. Although the essential feature of acromegaly is hypertrophy of bone, many cases show demineralization of the skeleton.

Thyroid abnormalities are often reflected by radiologic disorders. Thus, in cretinism and infantile myxedema one sees delayed appearance of ossification centers, delayed union of epiphyses, or irregular ossification of epiphyses. The age when hypothyroid-

ism began may be indicated by the location of the epiphyses that show dysgenesis. Cardiac enlargement, pericardial effusion, or colonic dilatation may be noted in cases of myxedema. In simple and in toxic goiter, radiology is of value in demonstrating the presence or absence of a retrosternal extension.

Hyperparathyroidism is characterized radiologically by generalized decalcification; multiple cyst-like tumors of long bones, mandible or maxilla; and by metastatic soft-tissue calcifications. In hypoparathyroidism there may be increased bone density and brain (basal ganglia) calcifications without involvement of other soft tissues.

Presence or absence of adrenal tumors may be best established by presacral air insufflation. Adiposity may make film interpretation unreliable in cases of Cushing's syndrome, but radiographic findings in that disease, such as bony rarefaction of pelvis, ribs, and spine may be helpful.

Hypogonadism primary in the testes, if present before puberty, is usually indicated by very small testes. If hypogonadism is secondary to pituitary insufficiency or develops after puberty, the testes will be larger. When the testes are normal in size, x-ray bone age determinations may make the diagnosis. Delayed union of epiphyses would indicate that the lesion arose before puberty and therefore must be due to hypopituitarism. Normal bone age would indicate that the conditions arose after puberty and would not differentiate primary and secondary hypogonadism.

Bone age studies are helpful also in diagnosing dwarfism. Before puberty, bone age is normal in genetic dwarfism, whereas there is delayed epiphyseal union in pituitary infantilism. Premature union of epiphyses and transverse lines of arrested growth in long bones suggest that the infantilism is due to the cachexia of malnutrition, chronic infection, or metabolic disease.

In sexual precocity, bone growth and epiphyseal union are accelerated; and this is also seen in adrenal virilism from adrenocortical hyperplasia. Cortisone is used to depress the output of corticotrophin in these cases, but excessive cortisone will retard bone growth. Therefore to regulate cortisone dosage it is important to follow the bone age by x-rays.

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**The Radiology of Endocrine Disorders. A Symposium. II. Hypothyroidism in Children.** R. Astley. *Brit. J. Radiol.* 31: 346-352, July 1958. (United Birmingham Hospitals, Birmingham, England)

This presentation reviews the subject of juvenile hypothyroidism, with special attention to the differential diagnosis. X-ray signs are grouped by the author as follows: 1. Delay in appearance and growth of ossification centers. 2. Dysgenesis of ossification centers for the epiphyses and small round bones. 3. Occasional nonspecific broadening, thickening, or bony condensation of metaphyses. 4. Miscellaneous signs including: bones shorter than usual; hypoplasia of one or two vertebrae in the thoraco-lumbar region; accessory epiphyses at the metacarpal bases; hypoplasia of phalanges of the little finger; delayed closure of skull sutures and fontanelles; delayed dentition; wormian bones; delayed mastoid and paranasal sinus pneumatization.

In general, normal bone age in the presence of retarded development has more significance than does the finding of retarded skeletal maturation. Normal bone age excludes hypothyroidism, whereas retarded

bone development by itself is not diagnostic. It should be remembered that with treatment the delayed bone age of hypothyroidism may be replaced by advanced development.

Epiphyseal dysgenesis in hypothyroidism is significant. It must be differentiated from aseptic necrosis and from the occasional normal epiphyses which ossify from several centers or in an irregular fashion. Distinction must also be made from dysplasia epiphysialis multiplex, which is a rare developmental condition often with many of the radiological signs of hypothyroidism. Two cases are reported in which roentgen findings suggested hypothyroidism but that condition appeared to be ruled out by failure of growth response to thyroid administration and normal intelligence.

Twenty-two roentgenograms; 1 table.

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**The Radiology of Endocrine Disorders. A Symposium. III. Radiology of the Suprarenal Glands.** J. W. Laws. *Brit. J. Radiol.* 31: 352-360, July 1958. (Hammersmith Hospital, London, W. 12, England)

X-ray examinations of the suprarenal area may best be made by plain films of the abdomen, excretion urography, aortography, and presacral gas insufflation with body-section radiography. Examinations of other systems for secondary evidence of suprarenal disease vary with the individual case and the systems most likely to be involved.

The suprarenal glands differ widely in size and shape, and normal pneumograms may not exclude the presence of a tumor.

Adrenal calcifications may occur following the hemorrhage of Waterhouse-Friderichsen syndrome, tuberculous infection, generalized xanthomatosis, and neuroblastoma, and occasionally may be seen in the wall of a cyst. In Addison's disease the calcification may range from faint stippling to a heavily calcified caseous mass.

Symmetrical adrenal enlargement may be seen on pneumograms in congenital adrenal hyperplasia, adult adrenogenital syndrome, Cushing's disease, and primary aldosteronism. If adrenal enlargement is unilateral, as in the presence of a tumor, the opposite adrenal is usually atrophic.

Pheochromocytoma may be located in the retroperitoneal ganglia outside the adrenal. Presacral air insufflation with body-section radiography may be helpful in demonstrating size, number, and location of the tumor or tumors.

Tumors such as ganglioneuroma and neuroblastoma may become large enough to cause pressure symptoms and to displace or distort neighboring structures.

The author includes in this article concise summaries of the important clinical and laboratory findings associated with adrenal abnormalities of all sorts.

Fourteen roentgenograms; 2 photographs; 3 drawings.

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#### MISCELLANEOUS

**Contribution to the Diagnosis and Etiology of Spontaneous Pneumoperitoneum in the Newborn.** H. G. Wolf. *Radiol. clin.* 27: 193-197, July 1958. (In German) (Universitäts-Kinderklinik, Vienna IX, Austria)

Three instances of spontaneous pneumoperitoneum in



the newborn are reported. In the first case, there was a lengthy aganglionic segment in the colon (extending most of the way between rectum and splenic flexure), with a perforation in the ascending portion near the cecum. Exploratory laparotomy revealed masses of meconium in the abdomen, with severe peritonitis. Death occurred from circulatory insufficiency. In the second case, the perforation was in the proximal ileum, and resulted from volvulus of the colon due to an excessively long mesocolon. Despite surgical correction, the patient succumbed from cardiac failure. In the third case, the pneumoperitoneum was secondary to pneumomediastinum, itself consequent upon diffuse bronchiolitis. Autopsy showed, in addition, a Fallot's tetralogy and other congenital malformations.

Six roentgenograms. E. R. N. GRIGG, M.D.  
Cook County Hospital, Chicago

**Localized Atrophy of the Spinal Cord.** H. H. Jacobsen and K. Hyllested. *Acta radiol.* 50: 211-216, July-August 1958. (Bispebjerg Hospital, Copenhagen, Denmark)

The authors report 6 cases of segmental spinal cord atrophy, which, to their knowledge, has not been previously mentioned in the roentgenologic or patho-anatomical literature.

The condition consists of localized thinning of the cord, a few centimeters in length, with normal cord diameter above and below the area of involvement. Suboccipital air myelography with body-section roentgenograms affords the best means of detection. Myelography with radiopaque contrast media often fails to demonstrate the lesion.

Clinical signs in the patients were inconsistent and did not permit diagnosis. The lesions were related, respectively, to arteriosclerosis; incipient Charcot-Marie-Tooth disease; atypical lateral amyotrophic sclerosis; possible anterior spinal artery syndrome; syringomyelia; and hereditary ataxia polyneuropathy.

Six roentgenograms. DON E. MATTHIESEN, M.D.  
Phoenix, Ariz.

## TECHNIC

**A New Technique for the Localization of Radiopaque Foreign Bodies.** John R. Brown. *Ohio State M. J.* 54: 908-909, July 1958. (Good Samaritan Hospital, Dayton, Ohio)

According to the technic described by the author, radiopaque foreign bodies lying deep in the soft tissues

are first located grossly by anteroposterior and lateral films. For more accurate localization, two needles (21-gauge) are inserted, one parallel and one perpendicular to the floor, aimed at the foreign body. With the needles thus placed at right angles to each other, exactly vertical and horizontal views are taken with a portable x-ray machine. The films are inspected and, if necessary, the needles are placed again and further films are obtained. With this technic shock and damage to large nerves or vessels are reduced to a minimum. The procedure is not applicable to large body cavities unless the cavity is opened and solid and hollow organs are protected.

Two reports of the successful localization of metal in the thigh are given.

Six roentgenograms.

**Simple Method for the Introduction of Large-Gauge Plastic Catheters.** Constantin Cope. *New England J. Med.* 258: 1000-1002, May 15, 1958. (VA Hospital, East Orange, N. J.)

A method for the percutaneous introduction of large-bore catheters without a surgical cut-down is described. It requires a length of polyethylene catheter and a needle somewhat longer but of a diameter 1 or 2 gauges smaller than the internal diameter of the catheter tubing. With the needle lying within the catheter, one end of the tubing is narrowed by stretching until it fits snugly over the needle shaft, comprising, in effect, a compound needle with an inner cutting point and an outer, closely fitting cannula made of plastic tubing. This can now be threaded into a vein without difficulty after a nick in the skin has been made. In this position, while a free return of blood is being obtained, the needle is held firmly by its hub with one hand, and the catheter is pushed freely up the vein with the other.

The applications of this technic to angiocardiology, arterial catheterization, thoracentesis, and abdominal paracentesis are discussed.

For angiocardiology, with the use of a 15-gauge or 16-gauge needle, a very large gauge tubing, up to PE 320 (Fr. 10.5), depending on the accessibility of a large vein, can be inserted without too much difficulty. The tip of the catheter can be made to lie in the brachial or even in the axillary vein, thus protecting the narrower antecubital veins from the irritative effect of large quantities of hypertonic radiopaque media. The flow through the tubing can be increased by burning three or four small holes in a spiral fashion around its termination, with a hot needle.

Two photographs.

## RADIOTHERAPY

**Post-operative Radiotherapy of Mammary Carcinomata.** Keith S. Mowatt, Kevin W. Mead, Keith A. Stevens, Bernard J. Perrett, and David H. Walker. *J. Fac. Radiologists* 9: 147-151, July 1958. (Queensland Radium Institute, Queensland, Australia)

Four modifications of the McWhirter technic of post-operative irradiation for breast cancer are described.

The first modification consists in use of a wedge filter for the internal mammary chain in cases where the chest wall may be ignored after radical mastectomy. The axillary and supraclavicular nodes are treated in the routine manner. With two wedge fields, 220 to 250 kvp, and 0.5 mm. Cu plus 1 mm. Al added filtration,

a midvolume dose of 3,800 rads is delivered in three weeks. Outlining the internal mammary chain with a Perspex jig and the use of a bolus plus the wedge serve to give a greater uniformity of dosage to the ipsilateral chain while sparing the mediastinum.

A second refinement consists in the use of applicators sloped from 30° to 45° on opposing tangential fields. This has the advantage of increasing the dosage in the center of the field and reducing the fall-off which occurs at the superior and inferior margins in the normal two-opposed field technic. The 45° sloped applicator is in general better suited to separations of over 21 cm. and the 30° slope for separations under 21 cm.



Recurrent tumor in a treated axilla challenges the therapist's ingenuity. The authors treat this area with a single plane, "after-loaded stabilized implant." The needles are introduced through the skin of the anterior axillary fold and forced straight back through the nodes. A Perspex stabilizer insures the accuracy of the implantation. End-loading saves crossing of needles, and after-loading diminishes exposure to the operator. Good results are obtained with 6,000 rads thus delivered in five days (at 0.5 cm.) without skin damage. When the implant is used to supplement a course of deep x-ray therapy in inoperable cases, 3,000 rads are delivered to a point midway between two planes of needles 2 cm. apart. These are also introduced more accurately with a Perspex stabilizer. The entire breast and regional node areas, in the inoperable cases, are given a total dose of 3,000 rads of heavily filtered x-radiation in three weeks.

In the event of the recurrence of a mass of tumor in an area that was previously adequately treated by radiation, the authors try an aggressive "hot seed" technic. Arguing that the tumor has never been irradiated before, they deliver a high dose with a permanent radon-seed implant directly into the center of the mass. The radon is prepared in 0.5 mm. wall gold capillary tubing which is rolled out to reduce volume and yield the desired potency in seeds of 2 to 3 mm. in length. This small size enables one to postulate a point source in the calculations. The authors have delivered 5,500-6,000 rads at the surface of 3 to 6-cm. axillary masses by this method and have obtained survivals with no recurrence for up to two years.

Eight figures, including 1 roentgenogram.

SAUL SCHEFF, M.D.  
Boston, Mass.

**Combined Irradiation and Surgical Treatment for Carcinoma of the Cervix. Analysis of 79 Cases of Wertheim Hysterectomy and Pelvic Lymphadenectomy.** John C. Weed. *Ann. Surg.* 147: 704-711, May 1958. (Ochsner Clinic, New Orleans, La.)

Although the five-year survival rate for carcinoma of the cervix (Stage I) may exceed 75 per cent with irradiation alone, there are still a certain number of cases that are radioresistant. Since the radioresistant lesions could not be determined before therapy, a program of complete irradiation therapy followed by radical hysterectomy and pelvic lymphadenectomy was instituted by the author in hopes of improving the end-results in Stages I and II.

After diagnosis and staging, lesions of Stages II, III, and IV are given immediate external irradiation therapy for a calculated tumor dose of 3,300 r. This is followed by radium application in the cervical cavity and vaginal fornices in an attempt to obtain 6,700 r at point A. Stage I lesions are treated by radium alone. After an interval of four to eight weeks, the patient is re-examined. Radical hysterectomy and gland dissection are then performed if there are no major complications. The operative technic is essentially that of Meigs, with minor variations.

The major complications from the surgery fell into two groups: lymph stasis and urinary tract damage. The chief complication of the irradiation was damage to the intestine.

There were no immediate or primary deaths in the author's series of 79 cases. The survival rate for 42 patients operated on five or more years ago was 73.9

per cent. The author felt that the preliminary irradiation therapy did not increase the technical difficulty or the operation, nor did it increase the postoperative morbidity rate.

One drawing; 6 tables.

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Baton Rouge, La.

**A Case of Chorionepithelioma of the Uterus with Pulmonary Metastases Cured by Operation and X-Rays.** F. J. Browne. *J. Obst. & Gynaec. Brit. Emp.* 64: 852-856, December 1957. (University College Hospital, London, England)

A case of chorionepithelioma following hydatiform mole in a 25-year-old woman is recorded. The hydatiform mole was passed in April 1946, after which the uterus was curetted. The patient menstruated regularly from August to December of that year and then bled every day from Dec. 20 until she was seen by the author on March 4, 1947. During this period, repeated Aschheim-Zondek tests were negative and curettings failed to show evidence of malignant disease. Curettage was again performed on March 5. The histologic sections were examined by a number of pathologists, who concurred in a diagnosis of chorionepithelioma. Aschheim-Zondek tests continued negative until May 27, when a report of "extremely weak positive" was received. A chest roentgenogram was normal in March 1947 and again in June.

On June 11, 1947, the uterus was again curetted. Bleeding was profuse and in view of this and absence of sufficient scrapings for histologic study, it was decided to explore the uterus digitally after vaginal hysterotomy. A tumor 4 or 5 cm. in diameter was felt on the posterior wall just above the internal os. On biopsy this was found to show definite evidence of malignancy. Panhysterectomy with removal of both ovaries was carried out on June 25. On July 6 a chest roentgenogram disclosed multiple secondary deposits in both lung fields. A full course of deep x-ray therapy (details not given) to the pelvis was well tolerated. Roentgen therapy was also administered to the chest, and was followed by complete radiological disappearance of the multiple metastases. The patient was seen in June 1957, at which time she was "extremely well."

A chorionic cancer composed of highly anaplastic Langhans' cells may produce little or no chorionic gonadotrophin. Too much reliance should not be placed, therefore, on negative or very weakly positive Aschheim-Zondek reactions if clinical signs, chiefly persistent uterine bleeding, indicate the presence of chorionepithelioma.

The demonstration of pulmonary metastases in a case of chorionepithelioma should not be regarded as a contraindication to removal of the primary tumor. Approximately 20 cases have now been recorded in which such metastases disappeared either spontaneously or after x-ray therapy to the lungs.

One table.

**Tumors in Childhood.** Umberto Cocchi. *Strahlen-therapie* 106: 163-190, June 1958. (In German) (Radiotherapeutische Klinik, Universität Zürich, Switzerland)

The author discusses in length statistics of malignant tumors in children. In Switzerland, 0.4 to 0.6 per cent of all cases of deaths due to cancer occur in children up to the age of sixteen. At the Radiotherapy Clinic of

the University of Zurich, 11,472 tumor cases were treated from 1920 to 1957; 334 or 2.9 per cent were in patients under sixteen. The author believes that the apparent increase in frequency of cancer in children is attributable largely to statistical factors and to the decrease in mortality from other childhood diseases, mainly infectious diseases and rheumatic fever.

An increase has been noted in brain tumors and leukemia. Of the malignant tumors seen in the Zurich Clinic, 47 per cent involved the nervous system; leukemia and other tumors of the lymphatic system accounted for 21 per cent. Other localizations were: the skeletal system, 14 per cent; urogenital system, 10 per cent; trachea and esophagus, 2.5 per cent; soft tissues, 2 per cent; liver and intestinal tract, 1.5 per cent; skin, 1 per cent; thyroid and pleura, 1 per cent.

Malignant tumors in childhood are a little more frequent in males than in females, while benign tumors occur slightly more frequently in females than in males.

Intracranial tumors—21 patients treated with surgery and radiotherapy, 86 patients treated only with radiotherapy—showed a survival after one year of 45.0 per cent, three years 36.0 per cent, five years 35.0 per cent, and ten years 33.0 per cent; 18.0 per cent of all patients were considerably improved and symptom free.

Other tumor groups are discussed, but not in the same detail as brain tumors. In 204 patients with

malignant tumors other than intracranial tumors, the results were less favorable than in the latter group.

Twenty roentgenograms; 6 photographs; 6 charts and graphs; 10 tables. JULIUS HEYDEMANN, M.D.  
Chicago, Ill.

**Glass Dosimetry of Soft X Rays.** Tor Brustad and Thormod Henriksen. *Brit. J. Radiol.* **31**: 163-166, March 1958. (Norwegian Radium Hospital, Oslo, Norway)

Utilizing commercially available microscope glass coverslips, the investigators measured the discoloration caused by high doses ( $1.5 \times 10^3$  to  $1.4 \times 10^7$  r) of soft x-rays (35 kev). The dose rate was determined by a high-rate ionization chamber with a thin cellophane graphite-covered window, which had been calibrated against a parallel-plate, free-air chamber. The change of light transmission was measured by a spectrophotometer at several wave lengths. Fading corrections were found to be a function mathematically expressible, independent of dose and wave length.

The authors conclude that glass dosimetry may be useful in measurements of soft x-rays and that further study is needed on the nature of the coloring process and the influence of chemical composition of the glass.

Six figures; 1 table. GEORGE L. SACKETT, M.D.  
Cleveland, Ohio

## RADIOISOTOPES

**Diagnosis of Intraocular Neoplasms Using Radioactive Phosphorus.** Clinical and Pathological Aspects. Herbert C. Allen, Jr., John R. Thomas, Henry E. Wahlen, Louis Dally, Jr., and Edward W. Griffey. *Texas State J. Med.* **54**: 17-21, January 1958. (H. C. A., Methodist Hospital, Houston, Texas)

Since May 1955, 25 cases of possible intraocular neoplasm have been studied by the authors with radioactive phosphorus, with the techniques of Thomas and his associates (*Radiology* **61**: 916, 1953) and Eisenberg and his group (*Arch. Ophthalm.* **55**: 52, 1956. *Abst. in Radiology* **67**: 795, 1956). Six of these cases showed an increased concentration of  $P^{32}$ . Four eyes were enucleated. In 3 of the 4, the diagnosis of malignant tumor was supported by histopathologic section. In the fourth eye, the tissue diagnosis was hemangioma of the choroid. A twenty-four-hour study in this case probably would have shown a decrease in radioactivity, indicating a vascular or inflammatory lesion.

No increase in concentration of  $P^{32}$  compatible with a malignant tumor was found in 19 cases. Two eyes in this group were enucleated. In 1 of these a malignant tumor was suspected clinically; this diagnosis was not supported, however, by the radiophosphorus studies or the histologic examination. In the other case the eye was enucleated because of intense pain. Examination confirmed the  $P^{32}$  diagnosis of an inflammatory lesion.

Lesions of the iris were surgically excised in 2 cases after no concentration of radiophosphorus was obtained. Histologic examination of the tissue of 1 eye confirmed the clinical diagnosis of a cyst, supporting the radioisotope study. In the other case, in which the clinical impression was malignant melanoma, the tissue report was negative for malignancy.

From the evidence at hand the authors conclude that radioactive studies of the posterior segment of the eye can be done as effectively as anterior segment studies.

**Haemorrhagic Thrombocythaemia. Report of Two Cases Treated with Radioactive Phosphorus.** James R. Fountain. *Brit. M. J.* **2**: 126-130, July 19, 1958. (General Infirmary, Leeds, England)

Hemorrhagic thrombocythemia is a rare bleeding disorder characterized by a persistently raised platelet count. Hemorrhage occurs most commonly from the alimentary tract and nose, occasionally with thrombotic episodes. The blood loss results in hypochromic anemia and leukocytosis. Two cases are reported in considerable detail.

The first patient, a 58-year-old white male, complained of intermittent unexplained episodes of abdominal pain associated with chronic bleeding from the alimentary tract over several years. Early studies failed to demonstrate a bleeding site in the gastrointestinal tract, and two laparotomies showed no visceral abnormalities. About six years after the initial diagnosis of hypochromic anemia presumably secondary to alimentary blood loss, a complete hematologic study was performed and the proper diagnosis made. A total of 9 mc  $P^{32}$  given intravenously in three equally divided doses at intervals of three months resulted in marked improvement. One year after the first dose of  $P^{32}$  the patient's blood picture was close to normal and there had been no evidence of bleeding for over nine months.

The second case is that of a 53-year-old white male with a history of recurrent episodes of bleeding from the alimentary tract over a period of several years, with severe hypochromic anemia requiring repeated transfusions. Removal of the spleen was followed by persistent melena. Brief spontaneous improvement then occurred, but after several weeks symptoms returned. About one year after splenectomy a laparotomy showed thrombosis of the splenic vein and parts of the portal vein, and cirrhosis of the liver. The diagnosis of hemorrhagic thrombocythemia was made two

years later, when a comprehensive hematologic study was done. Two intravenous doses of 3 mc  $P^{32}$ , separated by an interval of two months and supplemented with a course of intramuscular iron therapy, resulted in significant improvement in the blood status, as well as a cessation of intestinal bleeding.

The nature and etiology of hemorrhagic thrombocytopenia are discussed. It appears to be intimately related to other proliferative diseases of the bone marrow. In a considerable number of cases it has been associated with atrophy of the spleen or has followed directly upon splenectomy.

One photomicrograph; 1 chart.

JAMES W. BARBER, M.D.  
Cheyenne, Wyo.

**Giant Follicular Lymphoblastoma: Its Treatment with Radioisotopes.** John H. Lawrence and William G. Donald, Jr. *Ann. Int. Med.* **49**: 1-16, July 1958. (W. G. D., Jr., Donner Laboratory, University of California, Berkeley 4, Calif.)

The clinical and pathological findings in 20 patients with giant follicular lymphoblastoma are presented. The average age at onset was forty-eight years, with a range from thirty-two to sixty-five years; 12 patients were male, and 8 female. Initial involvement was localized to the cervical nodes in 11.

The original biopsy diagnosis in 11 cases was "benign" giant follicular lymphoblastoma (or giant follicular hyperplasia). In 9 cases some dedifferentiation was apparent in the original biopsy specimen but all showed the giant follicular pattern. The relative benign or malignant histologic picture of the original biopsy appeared to have little relation to the life expectancy in this series. Changes in the histologic picture between the original biopsy and the autopsy findings also failed to correlate with duration of the disease. The average duration of life in 4 patients who maintained the same picture was 4.9 years, whereas in 4 patients who showed further dedifferentiation the duration averaged 7.8 years.

Sixteen patients received radioactive phosphorus, of whom 5 were in the terminal stage of their illness. Of the other 11, 1 who received three courses of  $P^{32}$  but no roentgen therapy died of an acute myocardial infarction three and a half years after the last course of  $P^{32}$  and autopsy failed to show any gross or microscopic evidence of disease. The average duration of disease in the other 10 adequately treated cases followed to termination was 6.7 years, compared to the average duration of 6.0 years or less reported in the literature. Certain patients of this group were given additional local x-ray therapy for control.

The general plan of treatment was to administer fairly small doses of  $P^{32}$  intravenously at variable intervals to put the disease constantly under control. Repeated blood studies were made to determine the degree of bone marrow suppression, and the duration of therapy was determined accordingly. The usual fractional dose employed was approximately 1 mc and the usual interval between doses approximately one week. This, however, was highly individualized, with single doses as high as 5.1 mc, and intervals up to two months. The total dosage for a successfully treated case varied from 6.0 to 44.3 mc.

The authors conclude that radioactive phosphorus, alone or with local roentgen irradiation, may be the treatment of choice in giant follicular lymphoblastoma

and certainly merits serious consideration, particularly in cases with widespread involvement.

Eight tables. CHARLES M. GREENWALD, M.D.  
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**Distribution of Radioactive Tryptophan in a Patient with Metastatic Carcinoid.** Jack W. Cole and LeRoy M. Matthews. *Arch. Surg.* **76**: 912-913, June 1958. (Department of Surgery, University Hospitals, Cleveland, Ohio)

In a patient admitted to the hospital with a diagnosis of intestinal obstruction, laparotomy revealed a tumor in the terminal ileum. This was resected and shown microscopically to be a carcinoid. Palpation of the liver at the time of surgery disclosed a small solitary nodule, and it was decided to operate again. Five hours prior to surgery the patient received 25 microcuries of  $C^{14}$  tryptophan orally. At surgery the nodule, which proved to be metastatic carcinoid, was removed, and biopsy specimens of normal liver, skeletal muscle, and rectal mucosa were also obtained. Assay of these specimens for  $C^{14}$  activity showed marked uptake of the radioactive tryptophan in the metastatic carcinoid nodule. The following readings (counts per minute per milligram of dry weight) were obtained: carcinoid tissue, 1,205, skeletal muscles 1.0, liver 2.6, and rectal mucosa 5.0.

One table.

J. S. ARAJ, M.D.  
Toledo, Ohio

**Urinary Excretion of Radiovitamin  $B_{12}$  in Carriers of *Diphyllobothrium latum*.** Wolmar Nyberg, Ralph Gräsbeck, and Väinö Sippola. *New England J. Med.* **259**: 216-219, July 31, 1958. (W. N., Vasa Central Hospital, Vasa, Finland)

Nyberg, using the fecal excretion test, has previously shown decreased absorption of radiovitamin  $B_{12}$  by patients infested with the fish tapeworm, *Diphyllobothrium latum* (*Acta haemat.* **19**: 90, 1958). The study reported here is an extension of that investigation to urinary excretion values as determined by the Schilling urinary radioactivity test.

Subjects studied included 50 healthy controls, 50 nonanemic carriers of the tapeworm, 7 carriers with megaloblastic anemia, and 16 cases of true pernicious anemia. The Schilling test was performed in the usual manner following an oral dose of 0.5 to 2.0 micrograms of  $Co^{60}$ -labeled vitamin  $B_{12}$  (160 microcuries per milligram). Tests of the infested subjects were made before and after expulsion of the worms. Controls received one or more tests.

The average urinary excretion for the 50 controls was 16 per cent of the ingested dose. Pernicious anemia patients excreted between 0 and 2.2 per cent. All worm carriers with megaloblastic anemia had clear-cut pernicious-anemia values before expulsion of the worm. After expulsion 4 patients exhibited normal values but in 3 excretion remained low. Thirty-one of 50 nonanemic tapeworm carriers showed excretion values lower than normal, and in one-half of the remainder values were in the low borderline range. Excretion tests performed after expulsion of worms showed increased excretion with apparently steady improvement in  $B_{12}$  absorption and excretion as the time after worm expulsion increased.

It is theorized that the fish tapeworm impairs absorption of Vitamin  $B_{12}$  in an otherwise normal patient by taking up or altering the vitamin on a competitive basis

Some overlap values of controls and nonanemic worm carriers are perhaps due to differences in site of worm infestation in the intestine and/or other effects on the intestinal mucosa. A point of interest is that a few of the infested patients appeared to have the usual form of pernicious anemia in addition.

The authors note that the parasite named *Diphyllorhynchium latum* is perhaps not the same species in different parts of the world.

One scatter diagram; 2 tables.

JAMES W. BARBER, M.D.  
Cheyenne, Wyo.

**Ionization Build-Up in Upper Respiratory Air Passages During Teletherapy with Cobalt 60 Radiation.** E. R. Epp, M. N. Loughheed, and J. W. McKay. *Brit. J. Radiol.* 31: 361-367, July 1958. (Montreal General Hospital, Montreal, Canada)

When a beam of high-energy radiation passes through tissue, electrons in the surface layers are set in motion and travel varying distances, predominantly in a forward direction, before coming to rest. If the beam passes through a few centimeters of air before reaching a tissue surface, this forward motion of secondary electrons leads to a surface deficiency and underdosing of the superficial layers as compared with deeper layers. However, if the beam passes through several centimeters of tissue before emerging at the surface, electron equilibrium will exist at the surface as well as in the deeper tissues. These factors have practical importance in the treatment of surface lesions located in air cavities of the upper respiratory system.

The authors have investigated the status of electron equilibrium at air-tissue interfaces by means of experimental studies with cobalt-60 radiation with a Masonite phantom and small ionization chamber. The phantom had a small rectangular block of air simulating the air cavities of the upper respiratory tract, and studies were performed with beams of various size and various degrees of overlap of the air cavity.

It was shown that the radiation beam must be larger than the air cavity in all directions by an amount greater than the electron range in tissue, if the surface dose is to reach equilibrium value. Accordingly, treatment with small ports about the upper air passages might lead to insufficient doses in surface lesions, although the departure was found to be not greater than 10 per cent in this study.

Thirteen figures, including 2 roentgenograms.

DON E. MATTHIEN, M.D.  
Phoenix, Ariz.

**The Depressant Effect of Continuous Cobalt-60 Radiation on the Secondary Tetanus Antitoxin Response in Mice.** Richard D. Stoner and William M. Hale. *Radiation Res.* 8: 438-448, May 1958. (R. D. S., Brookhaven National Laboratory, Upton, N. Y.)

An investigation has been made of the effect of continuous exposure to cobalt-60  $\gamma$ -radiation on the secondary antibody response in mice. Radiosensitivity of the secondary tetanus antitoxin response in mice was demonstrated after rather low doses of continuous  $\gamma$ -radiation given at a rate of 4 rep/hr. Accumulated doses of 48 to 288 rep depressed antitoxin formation, whereas comparable doses of acute  $\gamma$ -radiation failed to do so. Acute doses of 350 to 650 rep, however, sharply depressed the secondary antibody response.

Extended periods of continuous  $\gamma$ -radiation from ten

to twenty-eight days to accumulated doses of 960 to 2,688 rep markedly depressed the secondary antibody response. An accumulated dose of 2,688 rep was needed to depress antitoxin formation to the level observed after an acute dose of 650 rep.

When the secondary stimulus of fluid tetanus toxoid was given prior to ten days of continuous exposure to an accumulated dose of 960 rep, the secondary antibody response was not depressed.

Irradiated mice recovered the ability to produce a normal secondary antitoxin response during the second week after an accumulated dose of 1,248 rep.

The secondary antitoxin response was depressed in mice given long-continued  $\gamma$ -radiation at a dose rate of 1 rep/hr.

One figure; 7 tables.

**Enhancing Effect of Continuous Cobalt-60 Gamma-Radiation on Susceptibility to Anaphylactic Shock in Mice.** William M. Hale and Richard D. Stoner. *Radiation Res.* 8: 449-459, May 1958. (University of Tennessee, Memphis, Tenn.)

Continuous exposure to  $\gamma$ -radiation from a cobalt-60 source at a dose rate of 4 rep/hr. was found to enhance the severity of anaphylactic shock in mice sensitized with tetanus toxoid and challenged one hour or seven days postirradiation with fluid tetanus toxoid. A sharp increase in susceptibility to fatal anaphylaxis was observed as the accumulated dose was increased from 192 to 288 rep.

Recovery from the enhancing effect of continuous  $\gamma$ -radiation began during the second week postirradiation; complete recovery occurred during the third week after an accumulated dose of 672 rep.

Anaphylactic shock was demonstrable in mice sensitized six months before challenge with the specific antigen. An enhanced susceptibility to fatal anaphylaxis was obtained when these animals were given an accumulated dose of 288 rep and challenged one hour postirradiation.

Passive anaphylaxis was more severe in irradiated mice sensitized with homologous antitoxin one hour postirradiation and challenged the following day with tetanus toxoid.

The antihistaminic agent Thephorin afforded complete protection from fatal anaphylaxis in irradiated mice.

Eight tables.

**Radium ( $Ra^{226}$ ) and Radon ( $Rn^{222}$ ) Metabolism in Dogs.** M. A. Van Dilla, B. J. Stover, R. L. Floyd, D. R. Atherton, and D. H. Taysum. *Radiation Res.* 8: 417-437, May 1958. (Radiobiology Laboratory, University of Utah, Salt Lake City, Utah)

The metabolism of radium in beagle dogs after a single intravenous injection was studied by the authors. The dose levels were selected to cover the range from the threshold of biological effect to severe biological damage. The lowest dose level (1-level) was taken as ten times the currently accepted maximum permissible body burden on the basis of microcuries of radium retained at one year per kilogram of body weight. Five higher dose levels were used, 1.7-level, three times the 1-level, and 2-, 3-, 4-, and 5-levels, going up by factors of 2, 3, 3, and 3, respectively. *In vivo* measurements showed that fractional radium retention,  $R$ , can be expressed as ( $R = 0.787t^{-0.100}$ ), where  $t$  is days postinjection. Since considerable radon was exhaled, the radon



content of the dogs was always less than the radium content, the ratio increasing to 0.2 in the first few months and remaining at approximately that value to the longest period of observation (three years). Plasma radium levels and excretion rates were also measured and found to follow power functions whose exponents are essentially equal to the exponent of  $-dR/dt$ .

Radon exhalation in dogs was compared with that in other species, and a theoretical approach is suggested, based on the recoil range of radon atoms and bone mineral ultrastructure.

Metabolism of radium and  $\text{Ca}^{45}$  in dogs was compared, and considerable differences were found in renal clearance rates, plasma levels, and skeletal binding. These differences cancel, resulting in essentially equal retention out to the longest observation period (one hundred days postinjection).

Radium retention in beagles was found to decrease as age at injection increased, the reverse being true of the plasma levels. This is consistent with the dependence of bone metabolism on age.

Calculations of average radiation dosage in beagles and people carrying radium burdens showed that an adult human being containing  $1\mu\text{C}$  of radium fifteen years postinjection is bracketed by the 1.7- and 2-level dogs, and a human being containing  $0.4\mu\text{C}$  fifteen years postinjection is bracketed by the 1- and 1.7-level dogs. Radiation damage can be demonstrated roentgenologically in the skeleton of human beings

carrying both these radium burdens, and, if both species react to cumulative radiation dose similarly, radiation effects should be observed on x-ray examination in 2-, 1.7-, and probably 1-level dogs. To date, definite changes have been observed in 2-level dogs.

Nine figures; 4 tables.

**An Electronic Method for Improvement of Contrast Scintigraphy of the Thyroid, Liver, etc.** Wolfgang Horst, Hans-Joachim Heymann, and Hans-Joachim Tepe. *Strahlentherapie* 106: 191-201, June 1958. (In German) (Universitätskrankenhaus, Hamburg-Eppendorf, Germany)

The authors describe an electronic method which improves the legibility of scintigrams by diminishing background activity through background suppression. The method is useful with direct recording as well as with photoscanning. Only those impulse frequencies produced on an organ are recorded which exceed a certain amount. Moreover, the amplitude of the impulses is so modulated that their height is proportional to the counting rate. Impulses of a minimum height pass through an amplitude discriminator before they are printed. This impulse discriminator makes it possible to record planes of selected activity. It increases the clarity of scintigrams appreciably, as is demonstrated in studies of the thyroid and liver.

Twenty figures.

JULIUS HEYDEMANN, M.D.  
Chicago, Ill.

## RADIATION EFFECTS

**A Testicular Shield.** Paul C. Hodges, Nels M. Strandjord, and Alice McCrea. *J.A.M.A.* 167: 1239-1240, July 5, 1958. (P. C. H., 950 E. 59th St., Chicago 37, Ill.)

In order to keep the amount of radiation to the testes as small as possible, a testicular shield for use during x-ray examinations has been devised. Rising from a Bakelite base  $1/2$  in. thick, with felt cemented to its undersurface, is a hollow steel post,  $3/4 \times 3/4 \times 15$  in., on which rides a bracket that carries the shield. Within the post is a 1-lb. lead weight attached to the bracket by a light cable chain passing over sheaves at the upper and lower ends of the post. The shield itself is an assembly of 1 mm. of aluminum, 1.5 mm. of lead, and 6.5 mm. of Lucite. The Lucite protects the printed instructions attached to the upper surface of the lead and projects 4.8 cm. beyond the lead to facilitate the proper centering of the shield. The aluminum provides mechanical support for the lead and threads for four retaining screws. When a male has been arranged for pelvic filming, the technician places the instrument on the table top between his legs with the tip of the Lucite at the superior margin of the pubic symphysis and then lowers the shield until it is in contact with the skin.

Phantom measurements indicate that in pelvic radiography at 80 kv., 100 ma., with 2-mm. aluminum filter at the tube, a target-film distance of 40 in., and a 16 to 1 grid, the dose to the testes protected by the shield is approximately 5 per cent of what it would be without it.

[A photograph of this device is reproduced in a paper on radiation hazards in *RADIOLOGY* 72: 484, April 1959.—Ed.]

One roentgenogram; 1 photograph; 1 diagram.

**Single Dosage X-Ray Radiation to the Lung and Posterior Mediastinum Through the Open Chest. I. Results in Dogs Receiving Dosage Between 6,000 and 15,000 r.** John J. Fomon, Harold Davis, Frank T. Kurzweg, Rufus K. Broadway, and John Chesney. *J. Thoracic Surg.* 35: 771-778, June 1958. (University of Miami School of Medicine, Miami, Fla.)

Information on single-dose roentgen radiation administered to the lung or mediastinum at the time of thoracotomy is lacking. It is suggested that patients with nonresectable tumors of the lung, esophagus, or posterior mediastinum might be candidates for this type of therapy, as well as patients whose tumors have been resected, but in whom there are positive regional lymph nodes. The authors undertook an investigation to establish the maximum safe dose of radiation that may be given by this method, to determine if such a dose is cancerocidal, to see if it produces less systemic effect than conventional forms of therapy, and to find out what complications can be expected.

Mongrel dogs weighing between 9 and 27 kg. were used in the experiments. A thoracotomy in the right fourth interspace was performed under sterile conditions. A circular cone made of sterile sheet lead was inserted into the posterior aspect of the wound in such a way that the tissues surrounding the portal of radiation entry were completely protected by at least 2 mm. of lead. The entry portal measured 28.26 sq. cm. In one group of dogs, the radiation was directed through the lung toward the posterior mediastinum (8,000 to 12,000 r to the lung surface and a depth dose to the esophagus of 5,200 to 7,800 r). Care was taken to see that there were no atelectatic areas during radiation. In a second group, the lung on the operated side was packed away from the entry portal, thus allowing the



radiation to pass directly to the mediastinum. Animals in this group received 6,000 to 15,000 r to the depth of the esophagus with the lung shielded.

Since all of the animals received much larger than calculated cancerocidal dosages of radiation through a relatively large port, it is not surprising that only 2 survived. In the first group, death was the result of pleural effusion or pneumonitis; in the second group, esophagitis with or without tracheitis caused death. Because of the high dosages employed in this series, no conclusions can be drawn concerning the clinical application of direct irradiation of the lung or mediastinum. Further investigation is warranted using lower but still cancerocidal doses.

Four photographs; 5 tables.

**Electrolyte Excretion in the Rat after Severe Intestinal Damage by X-Irradiation.** Kenneth L. Jackson, Robert Rhodes, and Cecil Entenman. *Radiation Res.* 8: 361-373, April 1958. (U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

The investigation of radiation dose-survival relationships in several species of laboratory animals has led to the identification of a specific lethal syndrome characterized by death within three to five days and associated with exposure of the intestinal tract. A striking feature of this syndrome is the development of severe diarrhea, which suggests rapid and excessive loss of water and electrolytes, a factor which has been considered as a possible cause of "intestinal radiation death."

A study was made of electrolyte losses incurred by rats x-irradiated with a dose (1,500 r) sufficient to cause severe intestinal damage and early death. Fasting rats were used because high doses of irradiation have been observed to cause anorexia in these animals.

Potassium excretion was increased on the first and third days after irradiation, and sodium excretion on the third day, just prior to death, which occurred during the fourth day. Analysis of fecal and urinary excretions separately indicated that potassium was lost primarily by way of the urine, while the irradiation-induced loss of sodium was by way of the gastrointestinal tract. The total potassium lost by the irradiated rats was 27 per cent greater than that lost by a control series, whereas sodium loss was 138 per cent greater.

The gastrointestinal tract content of electrolyte three days after irradiation with 1,500 r was also studied to determine to what extent electrolyte leakage into the lumen of this structure contributes to total-body loss of sodium and potassium. The content of sodium was found to be significantly greater than that of the controls, but the potassium content was not significantly different. The difference between the sodium content of the gastrointestinal tract in irradiated and control rats was due primarily to increased amounts in the large bowel; this is attributed to the increased fluid volume content of the cecum.

Under the conditions of the experiment, the mean sodium loss by the irradiated rats (including the excess in the gastrointestinal tract) beyond that due to fasting was calculated to be 1.50 mEq.

Removal of 1.40 to 1.54 mEq. of sodium by means of intraperitoneal dialysis with glucose solution caused death within twenty-four hours; death did not occur when 1.13 to 1.26 mEq. or less was removed.

It is concluded that x-irradiation of fasting rats with 1,500 r causes an excessive loss of sodium, principally by

way of the gastrointestinal tract, and that this loss is sufficient to produce death.

**Marrow-Cell Suspensions in Bone-Marrow Damage Due to Radiation.** Theodor M. Flidner. *Strahlentherapie* 106: 212-222, June 1958. (In German) (Universität Heidelberg, Germany)

The author irradiated inbred rats with 800 rep and 15-Mev electrons (Siemens Betatron). Following irradiation, the rats were injected with a bone-marrow suspension from unirradiated animals of the same strain, and their blood status was evaluated for twenty-one days. A second group of animals was similarly treated, but 3 animals were sacrificed after three, seven, and fourteen days for histologic and quantitative bone-marrow examination of the femur and tibia. A third group was irradiated with 600 r (200 kv, 20 ma). One-half of this last group received an intravenous injection of bone-marrow suspension. After one, three, five, seven, and ten days, 2 of the animals which received bone marrow and 2 of their irradiated controls were examined.

The injection of bone marrow after irradiation increased the survival time of animals greatly and accelerated the regeneration of blood. After three days regeneration of blood cells, especially red cells, is noticeable, and after six days erythropoiesis is often complete. Myelopoiesis is not accelerated by the injection of bone marrow. The degree of hemorrhage noted on the third day after irradiation was considerably less in the injected than in the untreated animals. The bone marrow injection did not influence the initial damage to the bone marrow seen twenty-four hours after irradiation.

The author suggests that it may be possible to treat the often fatal changes following total-body irradiation by injection of undamaged homologous marrow suspension.

Four photomicrographs; 7 charts; 4 tables.

JULIUS HEYDEMANN, M.D.

Chicago, Ill.

**The Effects of 2560 r of X-Rays on Spermatogenesis in the Mouse.** John H. D. Bryan and John W. Gowen. *Biol. Bull.* 114: 271-283, June 1958. (Department of Genetics, Iowa State College, Ames, Iowa)

Changes in the cellular composition of the seminiferous tubules induced by exposure to 2,560 r of x-rays have been analyzed by a quantitative histological procedure. These data have been compared with the results obtained following exposure to a much lower dose (320 r), in an attempt to gain further insight with respect to the manner in which the observed changes are brought about.

Exposure to 320 r results in a temporary maturation depletion of the seminiferous epithelium. This is brought about mainly by the inhibition of spermatogonial mitosis with irradiation-induced spermatogonial necrosis playing only a minor role. In contrast, exposure to 2,560 r produces a permanent depletion due to the fact that surviving spermatogonia are incapable of sustained regenerative efforts.

The frequency of necrotic spermatogonia, following 2,560 r, was found to be double the peak value attained in the 320 r material, or four times that of the corresponding controls.

Taken together, the data for the 320 r and 2,560 r experiments suggest that spermatogonial depletion is

brought about in two ways: (1) by suppression of mitosis due to inhibition of DNA synthesis, and (2) the killing of cells. Irradiation-induced necrosis plays a much more important role following exposure to high doses of x-rays. Even so the frequency of necrosis in either experiment did not reach very high levels, being about 9 per cent after the low dose and about 15 per cent in the case of the high x-ray dose.

Further evidence was obtained in support of the view that relatively heavily damaged cells may undergo degenerative changes prior to the onset of division, while less heavily damaged cells manifest degenerative changes only at about the time of entry into mitosis.

Four figures; 3 tables.

AUTHORS' SUMMARY

**Examinations of Radiation Effects on Liver, Spleen, and Kidney with an Electron Microscope.** Eberhard Scherer and Wolrad Vogell. *Strahlentherapie* 106: 202-211, June 1958. (In German) (Universität Marburg/Lahn, Germany)

The authors used the electron microscope to examine the liver, spleen, and kidneys of irradiated mice. Inbred mice of the same weight and sex were used for the studies. Total irradiation of 100 r was given (200 kv, 20 ma, 1.0 mm. Cu h.v.l.) and examinations were done one hour, twenty-four hours, three days, and seven days later. The structure of the mitochondria showed changes as early as one hour following irradiation, when clumping was observed. After twenty-four hours, the structure was partly destroyed, with clumping; after three days, vacuoles formed and septa were destroyed; after seven days, there appeared to be some restoration. These changes were seen in the kidney, liver, and spleen.

The authors believe that, contrary to previous opinions, the liver and kidney are radiosensitive organs. The structure of the mitochondria with electron-microscopic examinations can be used as direct measurement of cell damage. This method is considered superior to previously used cytological techniques.

Ten photomicrographs; 1 table.

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**Studies of Indirect Radiation Effects with Skin Grafting Experiments and Colorimetric Estimations of Erythema.** B. Jolles and S. G. Greening. *Brit. J. Radiol.* 31: 136-145, March 1958. (General Hospital, Northampton, England)

In a series of experiments with small grafts of irradiated skin in rabbits, the diffusible products from irradiated areas were studied and their relative importance colorimetrically gauged.

The influence on the radiation skin reaction of neighboring irradiated skin areas and the influence on the reaction of the unirradiated neighborhood were also studied in a series of volunteers.

The observations relative to the radiation injury and recovery factors are discussed. The practical inference from the authors' work concerns particularly the problem of the size of the holes in sieves (grids) used in therapy. Together with clinical observations the experimental findings should help in the elucidation of biological problems connected with sieve or grid therapy, such as the size of the apertures and the ratio of open to shielded areas which cannot be determined from purely physical considerations.

Eight figures; 6 tables.

**The So-Called "Recovery" Phenomenon and "Protection" Against X-Irradiation at the Cellular Level.** Roberts Rugh. *Biol. Bull.* 114: 385-393, June 1958. (Marine Biological Laboratory, Woods Hole, Mass.)

The often used terms "recovery" and "protection" in radiobiology are specifically defined. Recovery is a "restoration to the normal state." Protection simply refers to better survival and in no way implies saving the exposed cell from the sequelae of x-irradiation insult.

The prior finding of Henshaw (*Am. J. Roentgenol.* 27: 890, 1932) that a delay in insemination of *Arbacia* eggs following x-irradiation will allow for better initial cleavage percentage has been confirmed. However, it has been shown that there was no actual increase in ultimate cleavage percentage but rather, the x-irradiation factors which caused a delay in cleavage were neutralized. X-irradiated eggs never "recovered" because they could not develop through gastrulation to plutei.

Cysteinamine, if available to the *Arbacia* egg during x-irradiation, will counteract the delaying effect of x-irradiation on cleavage following insemination and will, in addition, allow further development. Some embryos will achieve the pluteus stage. This suggests that, in addition to the apparent "recovery" by delay in insemination, the —SH cysteinamine must in some way reduce or prevent irradiation damage to the nucleus in some eggs, allowing them to become ciliated blastulae and even stunted plutei. They do not develop further than abnormal plutei following x-irradiations above 50,000 r, even with the benefit of the cysteinamine, so that protection of the egg to allow normal development did not occur.

Cysteinamine imposed on the *Arbacia* egg after x-irradiation was so deleterious that the early cleavage stages disintegrated rapidly even in concentrations which were tolerated well by unirradiated embryos. This may be due to the anoxia caused by cysteinamine.

It appears that "recovery" from x-irradiation damage does not occur even with a delay in insemination. There may be some evidence of chemical nuclear "protection" to the extent that some eggs can develop to the early pluteus stage, but no further. It is concluded, therefore, that nuclear damage by x-irradiation is *irrevocable* and *irreparable* and that neither "recovery" nor "protection," properly defined, occurs at the cellular level following x-irradiation insult.

Four tables.

**The Effect of Revelators (Detectors) in Radiobiology and Radiotherapy.** Gian Giuseppe Palmieri. *Strahlentherapie* 106: 232-244, June 1958. (In German) (Istituto del Radio Policlinico S. Orsola, Bologna, Italy)

The author studied the effect of isotonic salt solution (Ringer's solution) on previously irradiated tissue of chick embryos as well as mouse tumors and, in a few cases, tumors of man. It is shown that the injection of different quantities of Ringer's solution into a tumor one to fifteen minutes, or even an hour and a half, after irradiation, caused effective decrease in the neoplastic elements even of radioresistant lesions. It is believed probable that Ringer's solution is effective because of a latent radiation effect on the permeability of the cell membrane in neoplastic or embryonal cells. The solution has no effect on normal cells.

Fifteen photomicrographs; 4 photographs; 1 table.

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